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Block Caving and Glory-Hole Mining at Copper Queen

By W. I. Nelson

Tractor Transportation for Mines in Northern Manitoba

By Earl Hanson

Development of a Copper Extraction Process

By Harmon E. Keyes

Mining Equipment Used in Other Industries . . . Can Africa's Railroads Carry Its Copper? . . . Changes in the Pachuca Operations of Real del Monte . . . Combating Corrosion . . . Progress at Sherritt-Gordon and Flin Flon . . . Complete Metal and Non-Metallic Mineral Price Quotations

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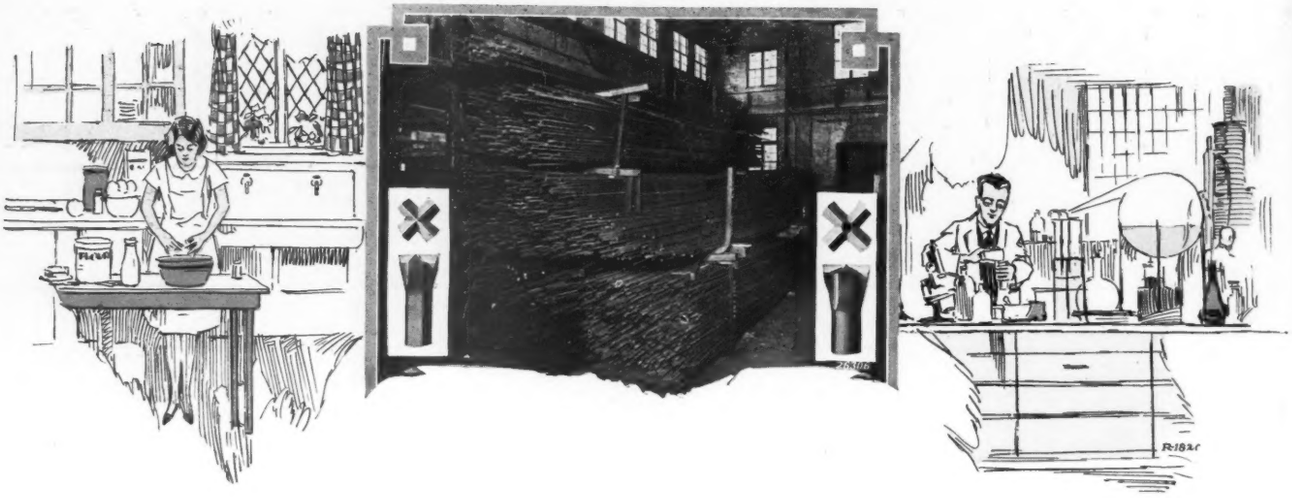

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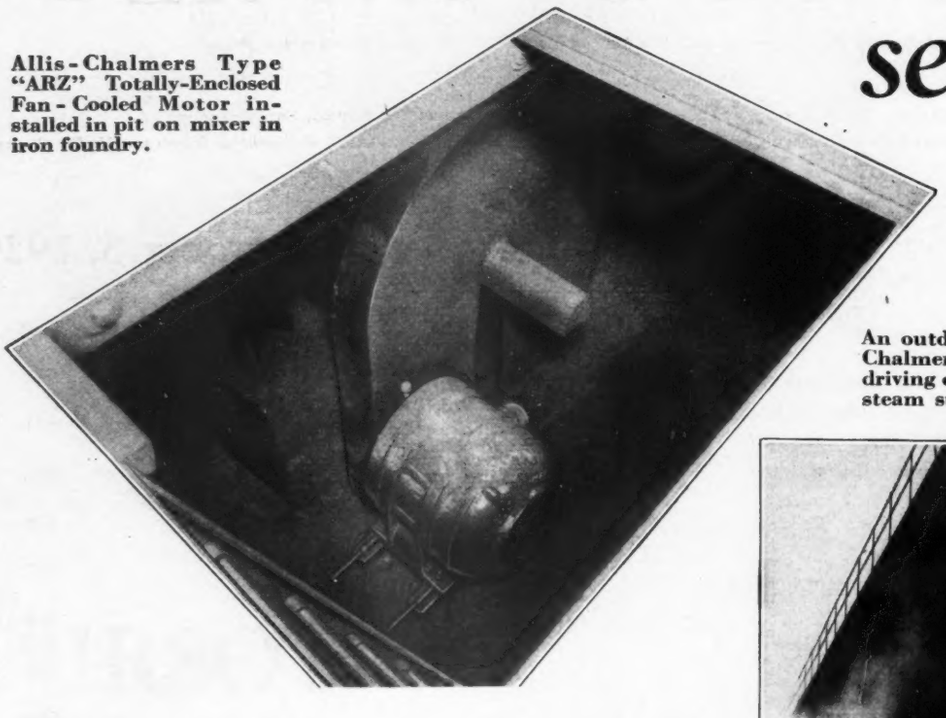
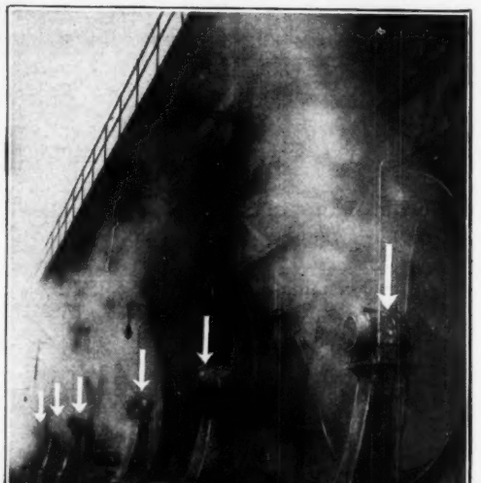
Speaking of severe service—



Allis-Chalmers Type "ARZ" Totally-Enclosed Fan-Cooled Motor installed in pit on mixer in iron foundry.

An outdoor installation of Allis-Chalmers Type "ARZ" Motors driving cooling tower fans. Note steam surrounding motors.



WHERE are the "severe service" jobs for motors in your plant? Wherever they are, and whatever the motor problem presented, there is an Allis-Chalmers Motor to efficiently handle it.

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Type "ARZ" Motor driving an apron conveyor under a shake-out pit in a large steel mill.

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ENGINEERING AND
MINING JOURNAL

A McGRAW-HILL PUBLICATION — A. W. ALLEN, *Editor* — ESTABLISHED 1866

VOLUME 128 — New York, October 5, 1929 — NUMBER 14

Producer Gas Power on Mining Properties

IMPATIENCE at the apparently slow march of progress may be tempered by looking backward and realizing the length of time necessary to effect a single improvement of importance. These comments are prompted by remembrance of conditions during the rainy season on a Rhodesian mining property before the War, when a deplorable waste of wood fuel, in frantic efforts to maintain steam pressure, was taken as a matter of course.

The collection and stacking of the fuel were expensive and difficult. The supply was running short. Each contractor had to lengthen his radius of operations. Despite the provision of every mechanical aid and alarm at the boilers, the loss of British thermal units was only one disadvantage of the time-honored method of utilizing the power locked up in a natural resource—by what is perhaps the most wasteful system.

Came a change in practice, inevitably but by no means hurriedly. The conviction grew that less wood could be used to produce more power. A suction gas plant was purchased and erected. In the six years following the change, the company, Lonely Reef Gold Mining, saved about £300,000 by the use of gas producers and gas engines, utilizing the same fuel. No stand-by unit was needed. The engines run continuously. A record of nearly 99 per cent performance is being made, day in and day out, throughout the year.

This is a fine achievement, indicating the important part that is being played by the manufacturer in the progress of the mining industries. The engine that was primarily responsible for the saving was not designed overnight, however. It came from the works of Crossley Brothers, pioneers in the development of the internal-combustion engine in Great Britain. The original Otto-Langlen gas engine was built by them in Manchester in 1869. This was of vertical construction, with cylinder below and crankshaft above, of a rating up to two horsepower. Then came the horizontal engine with compression before flame ignition. Later improvements included the poppet valve, and electric ignition.

The successful application of producer gas at the Lonely Reef should stimulate interest in this type of power elsewhere, where wood for fuel is available and economies are desired. Despite the part played by publicity, example and imitation are localized to a great extent. It is therefore not surprising that producer-gas plants have found greater application in Africa than they have in Mexico or Central America, for instance. The Rhodesian and General Asbestos Corporation has the largest suction gas-power plant in the world at the Shabanie mine. This, also, is a Crossley unit.

Striving for Records May Lead to Overstrain

THE superlative has become one of our commonest modes of expression. In an age when mechanical ingenuity produces miracle after miracle, our most common method of comparison has become the statistic; our most prized virtue, the creation of a new record. Every individual, it seems, nurtures within his breast the desire to do something better than any other individual. Apparently no field of human endeavor is exempt from this urge to excel. Size and speed and endurance have become the supreme attributes.

Engineering and Mining Journal recently published, in one issue, items concerning an 18-cubic-yard clamshell bucket, a 1,100-pound conveyor idler, a 510-foot chimney, and a 270,000-volt transformer, each of which in some way deserved the superlative. The spectacular achievement of yesteryear generally becomes the average performance of today. Albeit, the use of units of equipment of tremendous size permits economies that render profitable certain industrial operations that would otherwise be failures.

But too high a value can be put on size or speed or endurance—or any other quality, for that matter. Children in the city of Baltimore have been undergoing the peculiar form of torture known as flag-pole sitting, for the sole purpose of acquiring a little notoriety. In Colorado a man died recently from the effects of a voluntary 31-day fast. Our too eager critics pounce on these examples of apparent insanity, and condemn the entire age. What, they demand, will some future and saner generation think of us? The answer, of course, is that what they think does not greatly matter. And, if one is strictly committed to the philosophy of *laissez faire*, such inanities are not even disturbing. So long as the liberty or welfare of others is not affected, the participants are welcome to what pleasure they may derive or transitory fame they may attain from such exhibitions.

Unfortunately, however, the would-be record breaker may seriously affect the welfare of "the man in the street." The mania for building skyscrapers on Manhattan Island is slowly "congealing its traffic," to use Mr. Stuart Chase's phrase. It may seriously affect the health of countless metropolitan workers. Industrial organizations, bent on making output records, may push their ambitions too far, and find themselves in the position of having produced too much. Operations must then be reduced in scale, and employees must be discharged. In our own field, Hollinger Consolidated presents an unpleasant example of this aspect of breaking records. Mill capacity was increased more rapidly than ore reserves justified, in an effort to put the mine at the head of the

list of the world's leading gold producers. Now the company has much idle equipment on its hands.

Size, speed, or endurance should never be the ultimate goal. They are means, not ends, to attain whatever it is one wants. In attaining his desire, moreover, the seeker after a record must be careful not to tread on other people's toes.

What Every Mining Investor Ought to Know

MINING, to be successful, needs every legitimate aid in promotion and financing. In recent years the industry has gained prestige as a result of the operations of powerful holding companies with widespread interests, the management and direction of which are in experienced technical hands. The officers are usually eminent members of the mining profession, with reputations to maintain in that profession. Those who handle other people's money, even indirectly, should have reputations too valuable to lose.

The success of a holding and operating company such as Newmont Mining prompts emulation among those who are not so well known in the profession and industry of mining engineering. The flotation of a corporation of this type appears as an easy way to make money, but the sponsors sometimes exhibit a deplorable laxity in the manner in which vital information is handled.

In this connection, we feel obliged to analyze the offering of shares recently made by the North American Mining & Smelting Corporation, which, according to the statement, "now owns, controls, and has under option and/or consideration for ownership or control, mining and milling properties in Montana, Idaho, Washington, Oregon, California, New Mexico, Arizona, Colorado, and Wyoming." A pretentious coverage! "These properties have large proved and potential values in lead, zinc, gold, and silver. The corporation also owns 80 per cent of the stock of the American Boy Mining Company, Ltd., a British Columbia Corporation." This is the first definite indication in a prospectus worded to induce investors to part with $1,500,000 that the corporation owns a tangible asset. The curious will inquire about the American Boy property in British Columbia, to find that it is not even listed in the "Survey of Mines" of the *Financial Post*.

The company's title implies that it is engaged in smelting as well as in mining, or will become so engaged; but no evidence is adduced in support of this assumption. The prospectus states that the corporation's capital stock "possesses advantages peculiar to the so-called 'investment trusts' in that it embodies an unusual factor of safety made possible by the diversification of its holdings, both in metals and in districts, which reduces the element of risk to the lowest minimum possible in such enterprises, and provides a medium for reasonably safe and profitable investment in the metal and mining industry."

Engineering and Mining Journal demurs at the utilization of this argument as a recommendation in the present instance. Safety and profit are indicated only when some evidence is forthcoming that the holdings are promising, and that they have been selected by one or more engineers of high standing in the mining industry. Diversification is no recommendation by itself. As Mr. J. R. Finlay so wisely pointed out in our issue of September 14, the most important requisite in making a "lucky" investment in a mining district is "to discern the men and organizing processes destined to make the most of it." No casual reader of the prospectus in question would have reason to suppose that each of the directors of North American Mining & Smelting is not a capable man in his own field of endeavor, but only one of the ten is even a member of the A.I.M.E., and his record, as given in "Who's Who in Engineering," shows no experience in mining or smelting at any stage of his career. To this list was subsequently added the name of Mr. D. A. Callahan, of the Callahan Zinc-Lead Company. A San Francisco financial house also announces that a Mr. Joseph L. Coleman, referred to as the president of Ohio Mining Company, has been added to the list.

The moving spirit in the organization is apparently Mr. E. Marshall Young, who in a statement to the board of directors, subsequently issued in mimeograph form to prospects, described his sensations when he realized the potentialities of a mining promotion of this character. "In this new state of mind," he avers, "I felt as I imagine did Pygmalion when, glowing at the completion of his beautiful statue of Galatea, the latter suddenly became vitalized and colored by the flush of life." Follow references to the success of General Motors, American Smelting & Refining, and Newmont Mining. "With all of these facts in mind," he concludes, "I do not see how any other conclusion could be reached than that the possibilities for highly profitable operation of the North American Corporation are most assuring." Again, *Engineering and Mining Journal* is tempted to ask for precise information about the company's holdings, and also for the names of the engineers upon whose reports their acquisition was effected.

New Field of Usefulness for Barren Quartz

THE relation of ultra-violet rays to health, and the fact that ordinary window glass excludes those rays when sunlight passes through it, have long been recognized. Several years ago Professor Elihu Thomson, director of the General Electric laboratory at Lynn, Massachusetts, commenced a study of the subject, in an effort to develop a substitute for window glass that would not check these beneficial rays. Fused quartz was known to be suitable, but a manufacturing problem was involved. The melting point of quartz is nearly 3,200 degrees Fahrenheit—about three times that of glass. When melted it is extremely viscous.

Many methods of melting and fabricating quartz were investigated and special furnaces were developed before the General Electric Company finally succeeded in making quartz in sheet form, and at a reasonable cost. The crystal, crushed to one-quarter inch mesh, is fused in a vacuum on flat graphite disks between square, thin graphite slabs. Several of these trays are stacked in a

form and placed in a high-temperature furnace. When the quartz is fused, nitrogen gas is admitted to the furnace at a pressure of 150 pounds per square inch, to compress the bubbles. The resulting plates require only squaring of the edges by grinding. A considerable economy is effected by the avoidance of cutting, grinding, and polishing each pane.

As a result of this development, quartz glass can now be used extensively and at moderate cost instead of ordinary window glass. A new sanatarium at Saranac Lake, New York, has a solarium fitted with 1,200 fused-quartz window panes manufactured by the General Electric process. Thus, though the gold in quartz may purchase much that man wants here below, the most essential possession, good health, may be attained only by the wider use of the "barren" gangue mineral that to date has found only a limited use as an essential raw material for quality purposes.

President Hoover Directs Attention to Fire Loss

"FIRE PREVENTION WEEK," as proclaimed by President Hoover, will begin Oct. 6. Just another week to some; but thoughtful individuals everywhere, at home and on the job, will give it consideration. Fire losses last year in the United States reached the total of $475,000,000—a staggering figure, despite the fact that it is $85,000,000 less than the "record" established in 1926. Truly, this is a country where events occur on a magnificent scale—even waste by fire.

Much of this loss is caused by the stupidity and carelessness of the man who will never learn by observation, or take a leaf from the book of experience of others. His brains, if he really has them, are probably undeveloped. The acts of which he is guilty at times are on a par with smoking on a hydrogen-filled dirigible. Rules, if there are such and if this individual ever stops to think of them, are merely something to be broken. His habitat is everywhere, apparently, judging from statistics.

Fire has had its way in many a mining plant and camp. Sometimes the forest fire has been responsible. But more often the cause is attributable to the careless employee or to the superintendent who has failed to take precautions. In new camps in booming districts the fire risk often appears unduly great, even on superficial observation.

Who pays the fire loss? The insurance companies, of course, to some extent will reimburse the owner whose property has been damaged or destroyed, provided he has been properly covered. But more than the cost of the structure and its equipment is lost when a mine plant burns. Production ceases, for a time at least, and unemployment follows, and the aggregate loss to the company and the community is far greater than the amount represented by the so-called "fire loss" reported.

"Fire Prevention Week" should be more than just seven days. It should inspire continuous alertness in an effort to safeguard lives and property.

Making the Most of a College Education

WITHIN the last week or two, three or four thousand students in mining, metallurgical, and geological engineering have returned to the halls of learning in the United States. They have in mind, of course, to learn as much as they can about the immediate subject they have chosen to make their life work. Some will go to schools where there are few elective courses leading to the degree they wish to secure, and where the opportunity for attending interesting lectures and doing class work in other fields is not large. Others will attend large universities where mining is only one of the subjects taught, probably not considered so important as mechanical or electrical engineering, or law, or medicine, or even an ordinary "Arts" course.

One who has been out of college for many years is inclined to suggest to these budding miners and metallurgists and geologists that, even though this is an age of specialization, it is also an age when profound ignorance of any important byway of civilization may be found to be a definite impediment to personal progress. Mining, to a considerable extent, may be learned underground after graduation; and a post-graduate course in the school of experience will add much to the professional stature of other engineering graduates as well. Additional requisites are needed too, so the student would do well to pick up a few fundamentals of the other arts and sciences on which to build after he leaves school. No engineer should be without some knowledge of law, such as might be provided by even a two-hour course in specifications and contracts. He might well at least sit in on a course of lectures in psychology, which should sufficiently interest him to make him want to take more. Economics and finance are most important. Some knowledge of medicine and sanitation will often be found helpful. English is too often neglected. An engineer with ambitions must be able to write a proper letter of application for a job, a clear and concise report of work done or in progress, or an acceptable article for a technical publication or society. He need not take a course in oratory, but membership in a debating society for a year or two will help in the attainment of that ease of expression and quick thinking so necessary when he stands on his feet before the boss or the company directors.

Nor must social accomplishments be forgotten. A young technical man showing promise will probably be invited to the manager's home, where a knowledge of literature and the arts will be appreciated; where incorrect use of the knife and fork will be noticed; where some ability at bridge or poker is desirable. And some experience on the tennis court or golf course will not come amiss. Early training in these things can well be extended while at college, even though they are not in the curriculum.

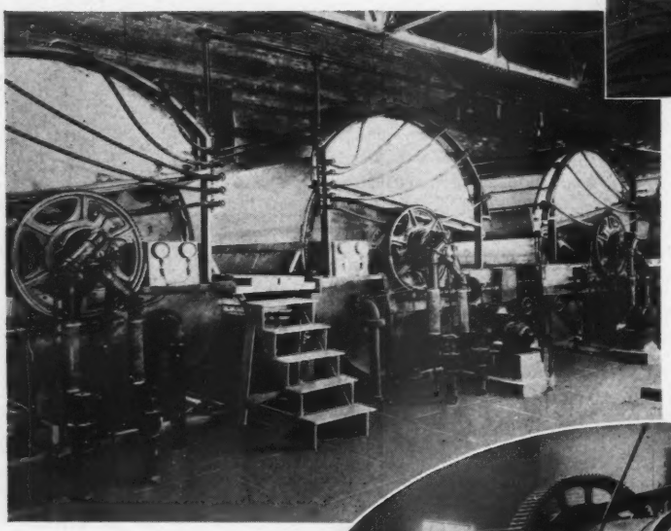
In other words, the mining graduate may know, not too much mining perhaps, but too little else. No doubt he will feel that the required college courses, plus the amount of whoopee that he finds necessary, will take up all of this time. But time can always be found for doing what one wants to do badly enough, and if the importance of some of the essentials mentioned above were realized, a better foundation for rapid advancement would be laid.

ILLUSTRATING—

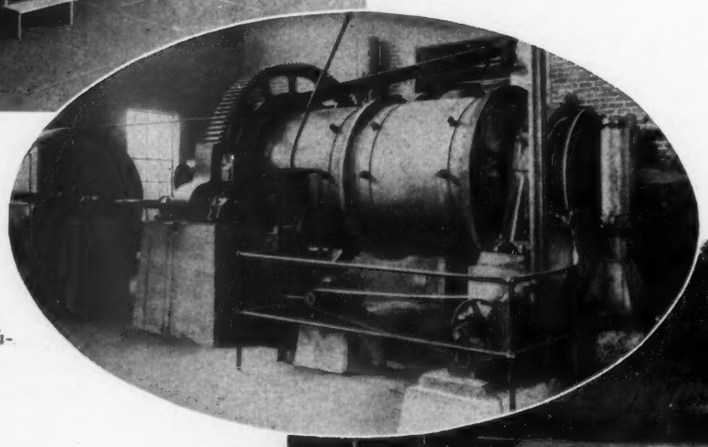
How Mining and Metallurgical Equip

THESE VIEWS ARE INDICATIVE OF THE WIDE UTILIZATION THAT HAS BEEN MADE OF MECHANICAL AIDS DEVISED PRIMARILY FOR THE EXTRACTION AND TREATMENT OF ORES

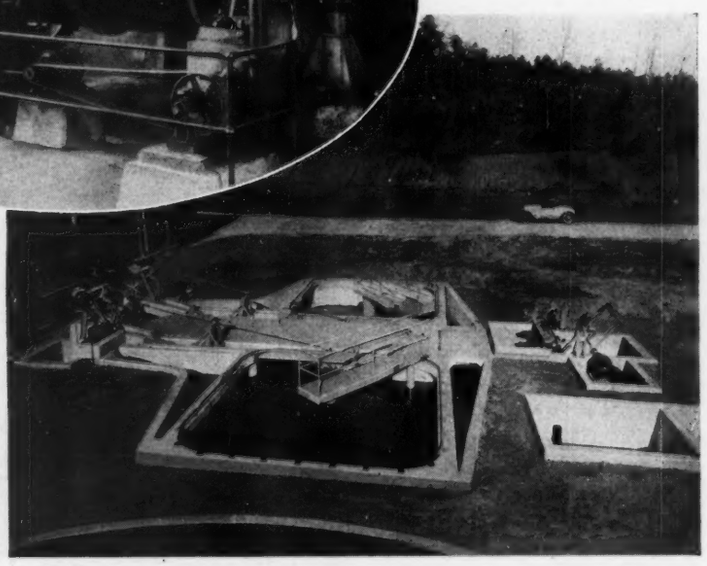
Above—Divers, with the aid of Ingersoll-Rand Jackhamers, remove a rock ledge in the East River, New York, in the interests of shipping



Left—Oliver filters are employed in the manufacture of sugar at the Grand Forks, Neb., plant of the Great Western Beet Sugar Company

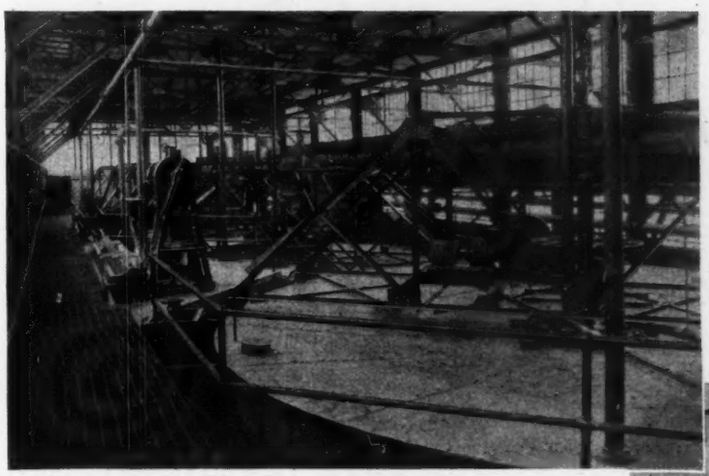


Right—Wheat straw is pulped in this Marcy rod mill employed by the Emerson - Carey Fibre Products Company, Hutchinson, Kan.

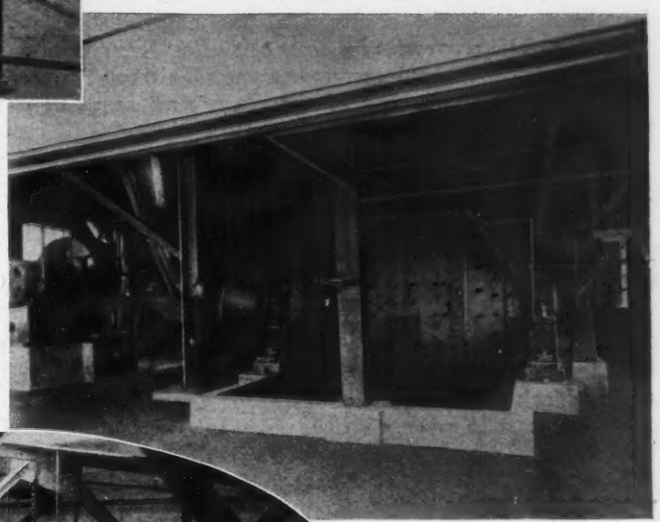


Right—Two Dorr detritors, developed from the Dorr bowl classifier, remove grit from sewage at the plant treating the sewage of Winston-Salem, N. C.

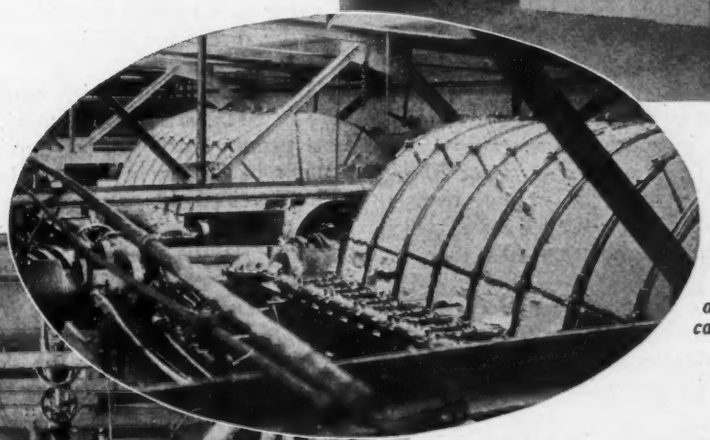
MENT HAS HELPED OTHER INDUSTRIES



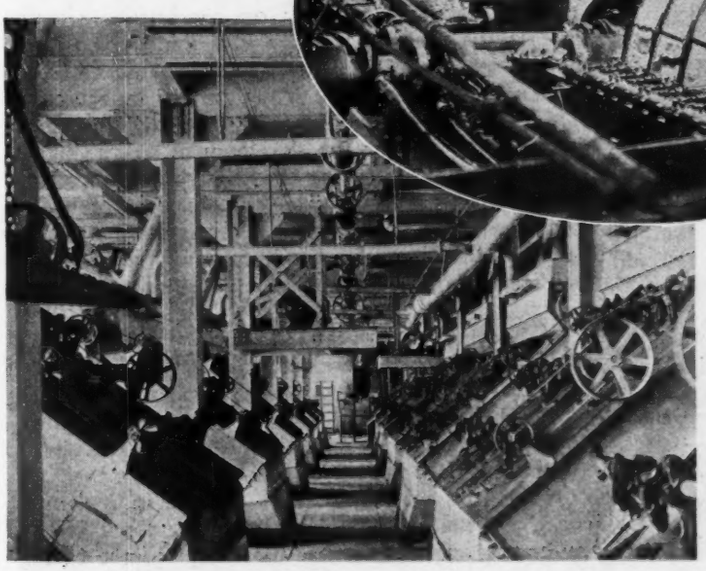
Left—These Dorr thickeners are used in the production of caustic potash by the Union Bag & Paper Power Corporation, Tacoma, Wash.



Right—Both anthracite and bituminous coal are ground in this Hardinge ball mill installed at the Middletown, Pa., plant of the Metropolitan Edison Company



Left—Ground wood pulp is treated on these American filters by the Escanaba Paper Company, Escanaba, Mich.



Left—Hum-mer screens, used for grading sugar at the world's largest refinery—the California & Hawaiian, at Crockett, Calif.

Block Caving and Glory-Hole Mining at the Copper Queen

F. W. NELSON
Phelps Dodge Corporation, Bisbee, Ariz.

THE vertical and horizontal boundaries of the Copper Queen porphyry orebodies, at Bisbee, Ariz., have been determined principally by churn drilling and to a lesser extent by underground prospecting. In some instances this underground work has been used largely to check the accuracy of the churn-drill-hole sampling. The recoveries in steam-shoveling Sacramento Hill and also in the underground caving have tended further to show the accuracy of this churn-drill sampling.

As far as known, the Copper Queen has four porphyry orebodies, all related to the so-called Sacramento stock. These are designated by their position with reference to the East orebody, which is cut by the Sacramento shaft and which extends northward under the remaining high portion of Sacramento Hill. This East orebody extends vertically from about the 200 level for a depth of about 250 ft., and a portion cannot be mined without jeopardizing the Sacramento shaft and the surface plant. Those caving blocks which are now laid out are far enough from the shaft to make it secure during the life of these blocks.

Extending from the lower part of the East orebody in the direction of the Lowell depot is the Southeast extension orebody, extending from about the 500 level to the 1,200. It is about 100 ft. in width and averages 450 ft. long down to the 950 level. The dip is at about 70 deg. to this depth. Near the 950 level the orebody tends to flatten out into a large inverted cone-shaped mass, which, as far as known, has its apex near the 1,200 level.

The third orebody lies to the northeast of the Sacramento shaft and extends from about the 600 to the 800 levels. No underground development has been done on this, known as the Northeast extension of the East orebody.

Of the porphyry orebodies the best known is the Sacramento pit or West orebody, which extends to the 400 level, or about 135 ft. below the bottom of the present lower bench of the pit.

The grade of the ore in these orebodies is not uniform. Included in the milling ore are irregular masses of high-grade material, and there are also horses, or bodies of waste.

Before it was decided to steam-shovel the West orebody, a stoping section had been laid out on the 400 level, but this was abandoned. On the 200 and 300 levels of the East orebody, a small amount of material was mined underground during the operation of the pilot mill for the Warren concentrator. The most extensive stoping operations were above the 1,000 level in the Southeast extension, where a large tonnage of the higher-grade porphyry ore was top-sliced and a lesser amount extracted by square setting. The lower-grade material around these timbered stopes will probably be caved with difficulty.

General Principles and Practice in Block Caving

Caving was probably discovered when the first miner encountered heavy ground. Later, caving was sometimes practiced where the cry for tonnage became too urgent upon the boss and he resorted to "pulling the lagging." Caving as a mining method has a number of variations, but this discussion will be confined to block caving.

Block caving, by which most of the low-grade copper ore in Arizona is being mined, is a development of the last twenty years. In the application of this system, the extent of the orebody must be determined in advance. The development program does not permit prospecting, but merely serves as a check on conclusions already drawn. If the orebody is large it is mined in a large number of sections or blocks. The horizontal and vertical extent of a given block is determined by the character of the ground to be caved and also by the length of time permissible for the development of the block. The vertical heights of caving blocks have been increased materially in recent years where the shape of orebodies has permitted such an increase. This is attributable in part to the elimination of hand tramming and also to standardization of the caving systems to suit local conditions.

In the Southeast extension orebody the height of the caving blocks has been increased from 60 ft. on the 600 level to 125 ft. on the present 850 caving level. The lift below the 1,000 level will probably be about 150 ft. Except for the earlier stopes, the heights of the blocks have been limited by the position of the ore. In the East orebody the lifts will be such as to take in its entire thickness, and the maximum height will be about 250 ft. In any caving operation where the height of the caving

Presented at supervisory staff dinner, Copper Queen Branch, Sept. 19, 1929.

block to be taken is being considered the possibility of greatly increased repair costs because of the longer life of the stope must be compared with the lower initial development cost.

The horizontal dimensions of a caving block may in part be determined by the size and shape of the orebody. To have the production coming from a number of sources rather than a very few is also advisable. This will give a more uniform tonnage production and also a more uniform grade of ore. In any orebody, the size of a caving block must be determined by trial and error, though very few errors are allowed. In the Copper Queen, the approximate size of the caving blocks has been 100x125 ft.

When the size and position of the caving blocks have been determined, the layout of the haulage level must be decided upon. In some instances the haulage level position may be such as to utilize a level already opened up in prospecting or in mining other orebodies. If such a level is utilized, the expense and time of running a new shaft pocket may be saved. Ordinarily, old mine levels are not designed to handle the large tonnages, and at best considerable alteration is necessary. Most of our limestone drifts are about 6x8 ft. in cross-section, but the porphyry haulage drifts average about 8x9 ft. In the Copper Queen caving operations a raise of less than 60 deg. pitch has been found unsatisfactory. Knowing the elevation of our grizzly level, the spacing of the haulage drifts can be determined. When the haulage drifts are complete, those haulage raises to be used in the first caving block are run to the grizzly level. The grizzly level may have been driven before the raises are complete, so as to save time.

When the haulage raises and the grizzly levels are completed the work of driving the fingers or openings from which the caved ore is to be extracted is begun. The first fingers run are those around the margins of the caving block, because these openings are to be extended upward through the entire thickness of the ore. These openings are not timbered any more than is necessary and are ordinarily stull raises. All of these vertical raises are connected by horizontal openings at regular intervals.

In some districts, such as at Ray, shrinkage stopes are run through the entire thickness of the ore around the margins of the block. In such practice the broken ore must not pack and the ground must be of such character as to permit long openings. Because the shrinkage stopes are empty when undercutting is started, the entire mass of ore may drop as a unit. In such circumstances the grizzly level is completely caved in and redevelopment becomes necessary under very trying conditions. This possibility of the block coming in as a unit has necessitated the present practice of weakening rather than removing the side support of the caving block. Moreover, the cost in such practice is less.

When the cutoff or boundary stopes are complete the work of undercutting or removing the support beneath the block is begun. The undercutting level is ordinarily about 16 ft. above the grizzly level timber. This feature makes it possible to have a support of solid ground above the place from which men will later extract the caved ore. The support beneath a caving block is not removed at one time, but small units are removed as rapidly as advisable, starting from one corner of the block. Determination of the rate at which undercutting should be done is based on judgment. If undercut too rapidly, the block does not take weight and cause a crushing action above the area undercut. If not undercut rapidly enough, the weight in the undercut portion may be transferred into the remaining pillars, making their removal dangerous or impossible. Where solid pillars are left on the undercut level a support is given to the ground to be caved and the weight is transferred to the grizzly level, and these openings are likely to be closed. All support must be removed from beneath any caving block.

When the block has been prepared as described in the foregoing, the solid ground in the block should start to cave owing to its own weight and lack of support. The tendency is to form a dome having its maximum height near the center of the block. Any dome is dependent upon the support around its base for its stability. In the caving block this support has been deliberately weakened, and the successive domes collapse as they tend to form. This collapse or sloughing is slow at first, but it accelerates until the block as a unit collapses and breaks up. The coarseness of this broken material affects the cost of drawing off the ore in the block. Sometimes the material is fine enough to pass readily through the fingers and on to the grizzlies. In other instances, where the material is coarse, a great deal of blasting is required to get the boulders through the fingers. When such material reaches the grizzlies, further blasting of the boulders may be required, or at least a double-jack massage.

As I have already stated, the amount and the grade of the ore in a given caving block is determined by prior prospecting. After the block is caved the problem of recovering the estimated amount of copper in the block presents itself.

A Practical Application of Block Caving

Let me assume that some one has a number of diamonds which he wishes to give me on a rather novel manner, under the following conditions:

The diamonds are mixed with 100 lb. of white sand and the mixture is placed in the bottom of a box. On top of this material red sand is placed so as to fill the box. I am to be allowed to remove only 100 lb. of material through the numerous openings in the bottom of the box, and the diamonds in this 100 lb. of material are to be mine. Of course, I have no desire to include any of the red sand in my 100 lb., and that the best method of recovering only the white sand is by removing a small amount of material from each opening in regular sequence is evident.

In a caving block the openings in the bottom of the box compare with the fingers of the caving block above the grizzly level. The white sand is the ore and the red sand the capping or barren material. The diamonds are the copper. If in the foregoing illustration no limit were placed on the amount of material I could remove, I could have taken all the material in the box and have recovered all of the diamonds. The unfortunate thing is that in the illustration, and also in block caving, the amount of material to be removed is limited.

In block caving, records of the amount of ore drawn from each finger are kept and also a record of the grade of this tonnage. Each finger has a certain tonnage and amount of copper to be recovered. In individual fingers the amount of copper recovered may be above or below the estimate, but for an entire block the recoveries as a

rule approximate the figures of the estimate. In each stope a man is employed whose sole duty is to keep a record of the amount of ore drawn from each finger and to take samples of the ore drawn on his shift. From these data, records of the stope production are kept and those places from which ore is to be drawn are designated. A block is not abandoned until the grade of the ore finally becomes so low as to make its extraction unprofitable.

Block-caving operations at the Copper Queen were started in the spring of 1925 on the 600 level of the Southeast extension orebody. Since that time caving levels have been worked out on the 650 and 725 levels. The present 850 level will be worked out early in 1930.

On the 600 and 650 levels, the Morenci timbered slide was used with moderate success, but on the 725 level these slides were discarded and a layout devised locally was employed. On the 850 level the spacing of the fingers was increased, and this innovation has tended to decrease repair costs materially. The 850 level will also see the complete elimination of hand tramming.

During the development of the present caving practice the heights of the caving blocks have been increased as much as is permitted by the pitch of the orebody. The first blocks were 50 ft. in height, and the present 850 level has blocks 125 ft. high. On the 950 caving level the layout to be used will be identical with that of the East orebody stope, which I will describe later. I should also mention the fact that the tonnage production of the Southeast extension orebodies has shown a gradual increase without material increase in the size of the stoping areas. Also, the production at present is much more uniform than in the earlier operations.

To clarify some of the points that I have tried to bring out, the layout of one of the caving blocks of the East orebody may well be considered. In this block, work has been done toward its development on four mine levels, the 500, 400, 300, and 200. The motor haulage is on the 500 level, and will serve all of the present blocks of the East orebody as well as the West orebody glory-hole operations. All of the workings on the 500 level have been driven in the last two years. The shaft pocket into which the ore is dumped from this level is new and has a capacity of approximately 1,500 tons of ore.

The ore is loaded into the skips on the 600 level. The grizzly level is on the 400, and some of the old workings have been utilized to advantage. To facilitate operations, the cutoff or boundary stopes of the block have been driven from the 300 and 200 levels. In other words, these cutoff stopes were driven upward from the 400 to the 300 level and then from the 300 level to the 200. On the north side of the block these openings extend a short distance above the 200 level. On the 400 level our grizzly drifts are spaced at 40-ft. centers and are run at right angles to the haulage drifts below and directly above the haulage raises, which are also at 40-ft. centers along the haulage drifts.

Openings into the grizzly drifts from below are spaced at 20-ft. centers along the drift. These openings are covered by rails spaced at 16-in. centers, so as to prevent large boulders from entering the haulage raise. From the grizzly, openings are driven upward at right angles to the grizzly drift, so that they will intersect the undercut level at a point 8 ft. above the grizzly drift timber, on 20-ft. centers. These openings are known as fingers and are the holes through which all of the broken ore is extracted. These fingers are connected on the undercut level by horizontal openings. The blocks of solid ore remaining on the undercut level after the fingers have been connected are known as pillars, which must be removed before the block will cave. Into each of the pillars a stub drift is driven to facilitate the removal of the pillar. When the cutoff stopes were complete, the shooting in of the block is started. Two pillars have been shot in each three days by a gang of four men. Holes are drilled outward into the pillars from the various openings, and also upward, the holes then being loaded and all of those in the two pillars are blasted simultaneously with electric detonators.

After the pillars are shot in, as much broken material as possible is drawn out from the fingers beneath the pillars. If this is not done, no room remains for more rock to break up, and weight may be transferred to the grizzly drift below. After this swell has been drawn off, some time may elapse before more ore can be drawn unless the block has started to crush. This general caving does not begin until about two-thirds of the block has been shot in, except where the ground is very heavy.

After a pillar is shot in, that part of the undercut level is abandoned and all further mining is done from the grizzly level. In undercutting, manways are always provided ahead of the pillars to be blasted as a means of escape, an important feature of the work and one that greatly facilitates the handling of supplies. The last pillars in a caving block are usually the most difficult to bring in, especially if the block is taking excessive weight. Here, speed is essential.

On the undercut level as little timber as possible is used. Any timber that is used must be blasted out when the pillars are shot in. After the block has been entirely undercut and shot in, the task of drawing the broken material onto the grizzly level, and also keeping the various openings in repair, presents itself. The goal is then to recover all of copper estimated to be in the block without any excess tonnage of rock.

The Glory-Hole Operation

The mining of the lower portion of the Sacramento Hill or West orebody by steam shoveling presented haulage problems which were expected to increase mining costs and also to decrease production. For this reason the management decided to recover this ore from underground by glory holes. Six glory holes, according to calculations, could be spaced so that most of the ore could be drawn out on the 400 level. When mined out these glory holes will leave a crater with slopes of about 45 deg. From the 400 to the 500 level large haulage pockets have been brought up directly beneath each glory hole from a large loop drift. The vertical distance from the 500 haulage level to the 400 is 90 ft.; from the 400 to the bottom of the pit it is 135 ft.

The haulage drift to serve the glory holes was driven from the 500 level of the Sacramento shaft, over 2,000 ft. When the loop was completed the six haulage raises were driven. These raises have five compartments for the first 50 ft. above the haulage level. Above this height the size of the raise was cut down to about 8x5 ft. These raises are raw, but the chute fronts on the 500 level are heavily timbered, reinforced with rails and boiler plate, and the collars below the 400 level are lined with reinforced concrete. On this concrete collar 80-lb. double rails were placed so as to leave 20-in. openings between them.

Above the grizzlies a heavily timbered opening was

made about 10 ft. wide, 15 ft. long, and 8 ft. high. This timber is supplemented by steel rails and flat cable. This protection is needed because of the large boulders which may fall from the pit and also because of the large amount of blasting needed to break the boulders. In front of the grizzlies and bulldozing chambers, an L-shaped square-set eight-post raise was run up a distance of 90 ft. above the level. These raises could not be holed to the surface, because the steam shovels were still operating above them. In these raises 5-ft. posts were used.

To remove the timber from the completed raise, one-half of the posts on each floor were drilled, but in no instance were posts above each other drilled on adjoining floors. All of the drilled posts were then blasted, using a number of delay electric primers, the upper timber being shot first. The broken timber was then withdrawn from the 400 level without material difficulty. The hole so stripped was over 10 ft. in diameter and came within 40 ft. of the surface. Churn-drill holes were then sunk from the pit above the top of each underground opening. Several of these churn-drill holes were blasted simultaneously and an opening was made to the surface.

When production started, a number of churn-drill holes were spaced around the openings and were blasted. The resulting boulders were very large, and those which could be reached on the surface were drilled and blasted with pluggers by Mexicans working on ropes in life belts. As the craters opened up, the slopes became less steep and more opportunity was given to break the large boulders before they entered the glory holes. Also, a larger proportion of the ground was broken with the pneumatic drills. As the glory holing operation progresses, the use of the churn drills in breaking ground will diminish because of the increasing amount of ground toward the bottom of the holes.

In the glory-hole operation, one should bear in mind, all of the ore is broken by drilling and blasting, whereas in the caving operations the bulk of the ore is broken and crushed by its own weight in caving.

Motor Haulage and Porphyry Production

The present motor haulage levels are on the 500 and 1,000 levels of the Sacramento. The 500-level haulage will serve the entire East orebody and also the glory-hole operations of the West orebody. Three 6-ton trolley motors are used on this level, each pulling 60 tons of ore in 4-ton cars. On the 1,000 level 3½-ton cars are employed and are pulled by storage-battery motors.

When the block now being caved in the East orebody reaches full production its tonnage output should be 1,000 tons per day. The production of the glory holes will be 2,000 tons per day and the production from the 1,000 level of the Southeast extension, 1,500 tons per day. These tonnages will probably be increased as the operation develops.

Nickel Finds Greatest Use in Structural Steel

IN HIS chapter on nickel in the current issue of *The Mineral Industry,* Thomas W. Gibson gives some interesting data on the uses of nickel, which have expanded so greatly in recent years. The four chief uses, says Mr. Gibson, are (1) as a component of alloys; (2) as a surface coating for other metals; (3) as a chemical or catalytic reagent; and (4) as a pure metal.

Prior to the World War, approximately 75 per cent of the nickel production was used in the manufacture of nickel steel, for which the chief demand originated from armor-plate and ordnance equipment companies.

Mr. Robert C. Stanley, president of the International Nickel Company, estimates the various uses in which nickel is at present employed, as follows, based on an output of 40,000 tons a year:

	Tons
Nickel silver	6,000
Coinage	800
Nickel plating	2,000
Structural nickel-steel	14,000
Copper-nickel alloys	800
Nickel catalyzers	400
Edison storage batteries	800
Monel metal	8,000
Heat-resisting electrical alloys	2,000
Malleable nickel	2,000
Nickel-steel castings	800
Nickel-bronze	400
Corrosion resistant steels	400
Ferro-nickel alloys	800
Nickel cast iron	400
Miscellaneous alloys	400

Present tendencies in the employment of nickel seem to indicate that there is not likely to be much decline in its use for armor-plate or ordnance equipment, the estimate for which use is 4,000 tons per annum. New naval cruisers are not likely to cause a marked increase, since the trend of naval construction is toward the elimination of heavy protective armor in order to increase speed. The use of Monel metal is firmly established, and nickel-steel and nickel-steel castings in railroad equipment are coming more and more into favor. In fact, the use of nickel for improving cast iron is likely to become a standard practice.

The use of chromium with nickel for special steels is rapidly extending, and the nickel in such alloys accounts for 30 per cent of the annual consumption. The largest application of nickel-chromium steels is in the manufacture of automobiles. Nickel-chromium steel castings are highly regarded and will give the same performance as other alloy steels, but at less cost. In plating over metals, a film of chromium superimposed upon a film of nickel, and highly polished, gives a fine silvery effect, superior in this respect to nickel alone. A nickel-molybdenum steel, containing about 1.5 per cent of nickel and 0.25 per cent of molybdenum, is proving valuable for case-hardened roller bearings. An alloy of nickel with copper, containing 20 per cent nickel, is now being used for condenser tubes instead of brass, being practically immune to corrosion.

The amount of study and technical research now being bestowed upon nickel is bringing out more and more the almost innumerable purposes to which this metal may be put, since its essential qualities—the power of toughening and hardening steel, its resistance to corrosion, and its color potentialities—enable it to enter into a host of alloys, widely varying in composition and use.

TRACTOR TRANSPORT IN

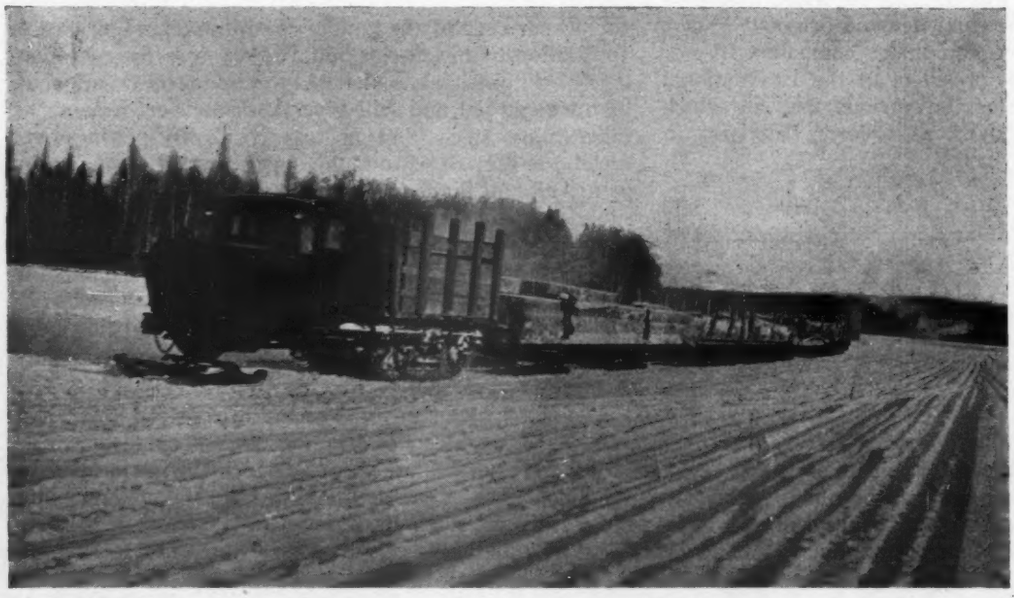
EARL HANSON

ALTHOUGH tractor haulage has in late years become increasingly important to the mining and engineering world, this form of transportation has probably not before been subjected to the stringent tests to which it was put in northern Manitoba last winter. Here, local geographical conditions offered an ideal testing ground, and mining and construction development at the Flin Flon, Sherritt-Gordon, and Churchill properties supplied the incentive for the successful results achieved.

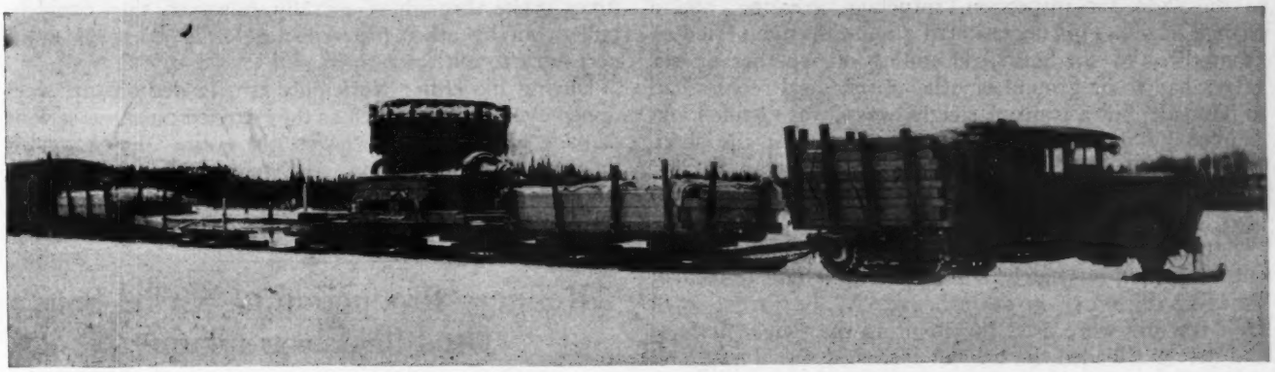
Away from the railroad, transportation work in the wooded regions of Canada's North is almost entirely dependent on watercourses. No roads penetrate through the bush, except at the portages between lakes. In summer, steamers and scows ply the rivers and the larger lakes, and freight canoes with outboard motors travel over routes that require portaging. In winter, dog teams and horse teams, traveling over the ice, have of late been supplemented by tractors. Airplanes, equipped with pontoons in summer and skis in winter, and using the lakes as landing fields, have become increasingly important in the last few years as a means of transport.

For long hauls in northern Manitoba, one type of tractor was used almost exclusively—namely, the Linn—built at Morris, N. Y. Holt tractors were used to a large extent locally for shunting material in yards. The advantage of the Linn for all-around work lies in the fact that it is not only a tractor but a cargo carrier as well. Its freight box is located directly over the caterpillars; this is a decided advantage in that it permits a juggling of weight to meet varied conditions. At ordinary times the added traction given by twelve tons of freight over the caterpillars is a great help, but the fact that the machine can be lightened by some twelve tons in case of accident, when it breaks through a bad spot in the ice or becomes mired, is also an advantage. Altogether, 27 Linn tractors were used in northern Manitoba in the last eighteen months; twelve traveled between Flin Flon and the new power site at Island Falls, six were used between Sherritt-Gordon and the new town of Cranberry Portage on the Flin Flon Railroad, four in transporting materials from Port Nelson to the new Hudson Bay port at Churchill, and the others singly at various places. Most of the tractors were 100-hp. capacity, although a few 60-hp. machines were in service. All of the three aforesaid major operations consisted of transporting materials for construction work.

Island Falls, on the Churchill River, is the site of the new 45,000-hp. power plant that is being built for the Flin Flon mine. Between the plant and the mine are 75 roadless miles, and, although Flin Flon has recently been reached by a railroad from The Pas, no present prospect is apparent that Island Falls will ever be on a railroad.



Lakes are the highways in northern Canada



Heavy loads are moved; the second sleigh in this train is carrying 38 tons

NORTHERN MANITOBA

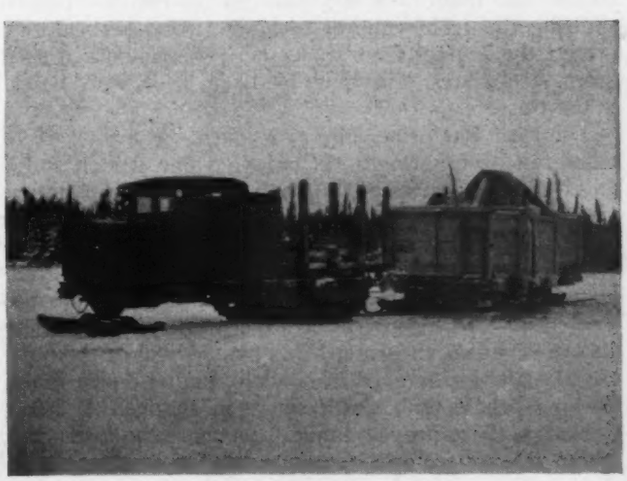
Sherritt-Gordon is being approached by a railroad line from Cranberry Portage; at the present writing all the grading has been completed, and steel is within ten miles of the mine. Tractor haulage over the ice was used last winter to supply the camps of the Dominion Construction Company, which company is building the railroad, and so that construction work could be undertaken at the mine before supplies might be sent in by rail. In passing, the reader may be interested to note that the new pioneer town of Cold Lake, near Sherritt-Gordon, received most of its supplies by tractor last winter, although airplanes, as well as dog teams, were also utilized. Exceptionally light snows of that year allowed regular taxicabs equipped with heavy-duty tire chains to carry passengers over the water route between Cranberry Portage and the Cold Lake route.

The outstanding success of tractor transportation in northern Manitoba has attracted wide attention in engineering circles. Letters, asking for details regarding methods, have poured in to the men who participated in the work. I saw one letter that asked for details so complete that any engineer, anywhere, could do the same kind of work. Obviously, to comply with this request was impossible. The success of a tractor operation depends on local conditions, the amount and kind of freight to be transported, and, particularly, on the knowledge and ingenuity of the men who undertake it. Although the work in Manitoba was aided materially by an exceptionally favorable winter, it was successful chiefly through the efforts of men who were thoroughly acquainted with local conditions and needs, as well as with tractors and the general problems of transport work. When tractors were tried during the war for hauling ore from the Mandy mine, they were utterly unable to compete with horse-drawn sleighs, partly because the machines themselves were at that time not sufficiently developed, and partly because skilled operators and mechanics to operate them were not available.

By far the most successful operation in northern Manitoba was the one between Flin Flon and Island Falls. The operating cost of the Sherritt-Gordon haul, on which one 60-hp. tractor hauled 3,600 tons of supplies a distance of 54 miles, was about 32c. per ton-mile, exclusive of the first cost of equipment. On the Flin Flon-Island Falls haul the ton-mile cost was about half this amount. All the engineers who saw the Flin Flon work being done agree that it probably holds the world's record for cheapness and efficiency. The contractor who planned the work and carried it out—namely, Charles Morgan, of The Pas—is accustomed to holding records. During the war, while hauling ore from the Mandy Mine, he set a Canadian record for horse-team transportation that has not yet been broken. Moreover, he won the 200-mile dog derby of The Pas three years in succession.

In less than two and a half months, between the eighteenth of December and the end of February, 24,000 tons of material was transported 75 miles from Flin Flon. The work was organized as a specific transportation job, not as an auxiliary part of the construction work. The tractors were idle only a minimum number of hours for overhauling in the shop. Three times as many sleighs were on hand as were carrying loads at any one time. When one loaded train arrived at Island Falls, a string of empty sleighs was always ready and coupled, so the return journey could be begun without delay. In Flin Flon, at the end of every trip, each machine always went

A tank sleigh used for icing portages



to the shop for inspection, refueling, greasing, and a change of oil. This necessitated a non-effective period of from three to six hours, depending on whether or not valves had to be ground or other mechanical repairs had to be made, but a train of sleighs was always loaded and coupled by the time a machine came out of the shop. Because of this uninterrupted service every train carried a caboose, fully equipped with bunks eiderdown sleeping bags, food, and a cookstove.

A train crew consisted of four men, one engineer and one brakeman on watch, and an engineer and brakeman traveling off watch in the caboose. At the yards, small Holt tractors were used for shunting the sleighs; cranes and derricks loaded the heavier pieces of machinery, and skids moved by man-power served for the lighter loads.

The usual round-trip period for each tractor was 36 hours, excluding the time it was in the machine shop. At first a trainload was only 15 tons, but later loads averaged about 80 tons, and one totaled 110 tons. The largest load for one sleigh was a piece of machinery weighing 38 tons. Loads of 35 tons were not unusual, although most of them ranged from 10 to 30 tons, depending on the nature of the material carried.

A total of 150 sleighs was especially built for the work by the Gregg Manufacturing Company, of Winnipeg. The method of coupling prevented any strain being transmitted through the sleighs, as, in pulling, all of it was taken up by the chains and eye-bolts and, in pushing and stopping, by the bunting poles. A complete record of all operations was maintained in Mr. Morgan's office in The Pas. Logs for all the tractors were kept in a card file, and for every trip a card was made out that showed the nature and weight of the load carried by each sleigh.

Average gas consumption for the loaded tractors was about one gallon to the mile. Although an emergency filling station was erected at the halfway point, and another at Island Falls, each machine left Flin Flon with enough gasoline to last the round trip. In addition to the regular gas tank under the driver's seat, with a capacity of 60 gal., an auxiliary 140-gal. tank was placed behind the cab.

When necessary, the tractor pushed a snowplow that cleared a 12-ft. roadway for the train. Few special precautions were needed to meet extreme cold, which often dropped to 45 or 50 deg. F. below zero. No extra lagging was needed on the oil pipes, but kerosene was used in the radiator instead of water. An iron plate was fastened in front of the radiators to prevent an excess of cold air from entering. This plate was hinged at the bottom and could be adjusted to special conditions of cold and wind by being swung in or out at the top. When heavily loaded, the tractors would rear up on the caterpillars, allowing the front runners to hang almost vertical. To protect the engines from the ends of the runners at such times, steel plates, ½ in. thick by 10 in. wide, were bolted to the tractors.

The road was principally over lakes, but a total of 18 miles ran over portages, 12 miles on one stretch and 6 miles divided between four others. Before operations were begun, about $50,000 was spent on these spots in widening them from canoe portages to roadways wide enough to allow the passage of tractor trains and in grading where necessary to keep the maximum grade down to 4 per cent. During operations, these land stretches were always kept iced, the water being pumped out of the nearest lake and transported in specially built wooden tanks. Seven of these tank sleighs were in service. A 2-foot thickness of ice proved ample to support the loads, but, where thinner ice was encountered, the tractors sometimes broke through. Generally, however, they could be pulled out by other machines, and seldom was a crane necessary to extricate them.

During the entire work only two loaded sleighs were tipped over, but inasmuch as they carried meat, no serious damage was done. Otherwise, the entire 24,000 tons of machinery, lumber, food, coal, tools, cement, and other supplies needed on the large construction job was delivered without damage.

Refinery Production of Nickel Salts Used for Electroplating

S. Skowronski
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IN THE usual analysis of copper anodes, the nickel will almost completely dissolve and foul the electrolyte; in the analysis of anodes containing a high percentage of nickel, however, some of the metal will be found in the slime. Nickel sulphate not only increases the resistivity of the electrolyte but also may cause the refined copper deposit to be contaminated with nickel. The refineries, therefore, prefer to operate with as low a nickel content in the electrolyte as they can, less than ten grams per liter, if possible, and with a maximum of twenty grams per liter.

To keep both the arsenic and nickel contents of the electrolyte within the prescribed limits, a certain amount of electrolyte is daily withdrawn from the circulation and purified. The method of purification of the electrolyte varies greatly, no two refineries using the same process. At a refinery selling 99 per cent bluestone, the free acid of the electrolyte will be neutralized with copper, and the nickel sulphate separated out from the mother liquors of a series of copper sulphate crystallizations. Usually, however, the copper is removed either by electrolysis with insoluble anodes or by a crystallization from the strong acid solution of 85 to 90 per cent of the copper as a commercial grade of bluestone, the copper in the mother liquors being removed by electrolysis.

The copper-free solution is evaporated in iron pans to fumes of sulphuric anhydride, whereby iron and nickel sulphates are salted out. The supernatent liquor contains the sulphuric acid and arsenic and may either be sold or distilled, resulting in pure 60 deg. Bé. acid and an arsenic salt cake. Then the anhydrous salts of nickel and iron, containing some free acid and traces of copper and zinc, are dissolved in water. The iron is oxidized with bleaching powder or lime and precipitated by means of lime, which also removes the traces of copper and zinc. As the entire operation is under chemical control, the resulting pure nickel-sulphate solution, after filtration, can be crystallized as high-grade nickel salts.

After an exhaustive study of the effect of impurities in nickel salts on the resulting electroplate, the U. S. Bureau of Standards recommended the following specifications for the single salts:

	Per Cent
Nickel, not less than	21.4
Iron, not more than	0.08
Zinc, not more than	0.05
Copper, not more than	0.02
Free acid, not more than	0.10
Insoluble, not more than	0.10

Nickel salts produced at copper refineries have had no difficulty in meeting these specifications and have been uniformly successful in the electroplating industry.

Development of a Copper Extraction Process

Segregation of Fines in Leaching Unit Suggests Their Separate Treatment

HARMON E. KEYES

Chemical and Metallurgical Engineer, Miami, Ariz.

MUCH of the recent hydrometallurgical progress in the Southwest has logically been in the development of methods to increase recoveries and lower initial cost of plant, thus tending to widen the scope of copper leaching and to decrease the financial burden of plant outlay, which heretofore has rather limited copper-leaching developments to orebodies of the first magnitude.

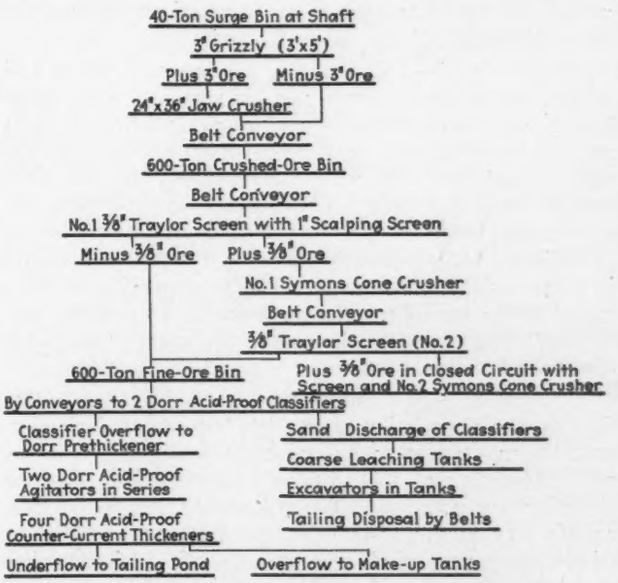
Research on methods of treatment has resolved itself largely into means of solving the slime problem, as operators have found that the clogging effect of fines, rather than refractory properties of the ore, impeded the dissolution of the copper minerals in percolation leaching. A noteworthy example of recent development in this department of metallurgy is the Zonia Copper Mining Company, of which W. J. Loring is vice-president and general manager and E. L. Sweeney consulting engineer. I made several visits to the Zonia, witnessed certain of the experimental work, and was much impressed by the clean-cut methods characterizing the organization, including the camp, mine, and testing plant. Appreciation is expressed for the co-operation shown by the management and staff in making the experimental data available for publication. Undoubtedly much of the success of this work, which included about 75 charges, totaling 175 tons of ore, should be credited to the competent supervision as well as faithful work on the part of the staff, particularly that of A. L. McFarland, who served as plant chemist and assisted the management in the conduct of research and test work.

The following account of the experimental work and proposed plant of the Zonia is given as furnished by officials of the company who are responsible for the present state of development of this process; it is presented to give the mining industry the benefit of some recent progress in copper leaching.

The developed orebodies of the Zonia are of a schistose character, but of various types. Practically all the copper-bearing minerals occur on the seams of the schist. Oxide copper, as determined by assay, is largely in the carbonate form, the so-called non-oxide being chalcocite, tenorite, and cuprite. The characteristics of this ore, which distinguish it from many other deposits, are more primary fines, greater ease of leaching when the fines difficulty is eliminated, and somewhat higher grade as to oxide copper content. Those fines that cause channeling in the leaching column are largely of primary origin, being principally kaolin filling of the schist seams. Secondary fines have little or no effect if above 150 mesh in size.

Experiments made at French Gulch, in Arizona, were in several stages—namely (1) crushing to ⅜ in., treating the aggregate in the same tank and charging by the Ajo method—that is, allowing the coarsest sizes to roll down the natural slope, thereby resulting in the coarse sizes being at the bottom and the fines at the top; (2) same as (1), but using horizontal bedding as formerly practiced at Inspiration; (3) same as (2), except that air in small quantities was introduced under the filter to loosen the charge; (4) same as (3), excepting that more air was added; (5) removal of the fines and separate agitation treatment thereof, the ore being crushed to ⅜ in. and acid classification being used.

The experimental plant was equipped for leaching by either series or batch methods up to a fifteen-ton charge basis, and including apparatus for crushing, screening, water or acid classification, agitation leaching of the removed fines, washing of charges, and precipitation of copper by scrap iron. Filter bottoms in the leaching tanks were made of boards with small, staggered holes. A completely equipped laboratory was also provided. Following are given the results of the testing work as mentioned in the above notations:


40-Ton Surge Bin at Shaft
3" Grizzly (3'x5')
Plus 3" Ore
Minus 3" Ore
24"x36" Jaw Crusher
Belt Conveyor
600-Ton Crushed-Ore Bin
Belt Conveyor
No.1 3/8" Traylor Screen with 1" Scalping Screen
Minus 3/8" Ore
Plus 3/8" Ore
No.1 Symons Cone Crusher
Belt Conveyor
3/8" Traylor Screen (No.2)
600-Ton Fine-Ore Bin
Plus 3/8" Ore in Closed Circuit with Screen and No.2 Symons Cone Crusher
By Conveyors to 2 Dorr Acid-Proof Classifiers
Classifier Overflow to Dorr Prethickener
Sand Discharge of Classifiers
Coarse Leaching Tanks
Two Dorr Acid-Proof Agitators in Series
Excavators in Tanks
Four Dorr Acid-Proof Counter-Current Thickeners
Tailing Disposal by Belts
Underflow to Tailing Pond
Overflow to Make-up Tanks

Solids flow sheet of proposed 600-ton plant; all crushing to be done in eight hours

Series No. 1—This was preliminary in nature, and poor extractions were experienced in all charges. The ore was well leached near the sides of the tanks, but near the tank centers the extraction at times was as low as 20 per cent. Segregation of the fines was quite pronounced in this series as well as in No. 2.

Series No. 2—This was conducted the same as series No. 1, except that the Inspiration method of charging was used. Little effect on segregation of fines was noted. Slightly less leaching time was used than on No. 1.

Comparison of Results of Various Series of Tests Made at Experimental Leaching Plant

	Series No. 1 All Minus ¼"; No Air, Ajo Charging	Series No. 2 All Minus ¼"; No Air; Inspiration Charging	Series No. 3 All Minus ¼"; Air Used; Inspiration Charging	Series No. 4 All Minus ¼"; More Air; Inspiration Charging	Series No. 5 ¼" Plus 65 Mesh; No Air; Charge Dumped In	Slimes Leach Minus-65 Mesh; Classifiers Plus Agitators
Heads, per cent total copper	4.39	2.88	2.371	1.947	2.00	1.90
Heads, per cent oxide copper	4.01	2.57	2.156	1.800	1.82	1.72
Tailing, per cent total copper	1.93	1.18	0.423	0.298	0.262	0.260
Tailing, per cent oxide copper	1.71	1.01	0.253	0.169	0.118	0.107
Extraction, per cent total copper	56.70	59.00	81.90	85.50	86.80	86.30
Extraction, per cent oxide copper	57.30	60.70	88.30	90.80	93.60	93.90
Days leached	11.20	10.20	6.10	7.30	3.40	5 min. to 1 hr.
Heads, per cent plus 6 mesh	42.50	44.50	46.50	42.40	45.30	All minus 65 mesh
Per cent plus 40 mesh	39.00	40.60	40.50	41.50	48.80	.....
Per cent minus 40 mesh	18.50	14.90	16.20	16.10	5.90	.....
Pounds 100 per cent acid per pound of copper extracted	1.92	1.92	1.92	2.08	1.87	1.89
Average acid content of leach solutions	1.91	2.09	2.20	2.20	2.09	1.79 at start; 0.30 at end
Average copper content of leach solutions	1.57	1.68	2.04	1.28	1.89	0.90

Series No. 3—The idea of using air at low pressure to blow the charges was carried out as at Anaconda several years ago. Extraction was somewhat improved, but still not considered satisfactory, as good extractions were obtained only after most careful charging. Air at 36-lb. pressure was blown from underneath the filter for two minutes every two hours. This method permitted reducing the leaching time several days. The solutions below the filter bottoms were allowed free passage and resulted in an even flow to all parts of the tank. The rate of blowing air was 16 cu.ft. per minute.

Series No. 4—This was the same as series No. 3, except that a larger quantity of air was used. The blow lasted four minutes at two-hour intervals, using 96 cu.ft. per minute. This gave a more open condition in the charge, and the extractions were raised on the oxide copper by 2½ per cent. This scheme showed great improvement over the first work, but was open to the objections that it would be difficult to equal test results in commercial practice and that large quantities of slime raised to the top of the charge would require subsequent settling. Furthermore, the recovery was still some 3 per cent below the ideal figures.

Series No. 5—To eliminate the troubles incident to fines in the percolation circuit, the operators decided to treat them separately by agitation leaching, following acid classification. The rate of leaching of fines in the classifier was noted. Agitation leaching was found most satisfactory in the Devereux type agitator. Separation of the fines was tried over a range of maximum sizes of 14 to 150 mesh. Material as coarse as 14 mesh could be fully leached by agitation in four hours. The maximum sizes of fines removed was gradually reduced without appreciable effect on the leaching rate in the percolation tanks. Although only the fines minus 100 or even 150 were thought to be responsible for all the channeling troubles in percolation, the work was standardized with the classifier overflow at 65 mesh, and such will be used in the commercial plant. The coarse ore, or sand discharge of the classifiers, was treated in exactly the same manner as the earlier charges, except that no special attempt was made to prevent segregation. Charging was done by simply dropping the sand discharge directly into the leaching tanks and allowing it to cone up until the tank was filled. About 17 per cent extraction was made on the sand discharge while in the classifier circuit. With the coarse ore thus prepared, the extractions were greatly improved, the leaching time being cut from a maximum of 6.1 days to 3.4 days. Better washing was also secured, even by cutting one day from the required time. Good washing results were obtained by circulating each wash four hours, a total of four washes being used.

The presence of fine sand having proved detrimental to tank leaching, the agitation treatment was confined to the finer sizes. Various strengths of leaching solutions were used in the classifiers, as the operators found that extraction of copper in the fines could be obtained by using a classifier overflow of 0.3 per cent sulphuric acid. The overflow was kept at 15 to 20 per cent solids. The sand in the classifier overflow gave up its copper in from five minutes to one hour. Excessive agitation and the use of stronger solutions did not produce any appreciable increased recoveries in the slime treatment. In this test work the Devereux type agitator was used. A partial analysis of the average ore used in Series No. 5 follows:

	Per Cent
Insoluble	84.40
Iron	4.10
Sulphur	0.20
Lime	0.80
Magnesia	1.60

The flow sheet of the "solids," on page 545, shows the most important items in the design of the commercial plant. A few of the features that differ from past standard practice will now be discussed.

Fir-wood tanks, lined with asphalt coating, will be used for all leaching, solution storage, agitation, and thickener tanks. Such were used in all the testing work, with no signs of deterioration. Duriron pumps gave satisfactory service in the test work and are to be used in the commercial plant. Piping is to be of acid-proof rubber hose which has been subjected to two years' work in the test plant. Pipe fittings are to be of hard lead and valves of Duriron and lead-lined iron. Classifiers, thickeners, and agitators are to be acid-proof Dorr equipment, which will include the Dorr countercurrent system for washing the slime charges. The tank doors are to be of Duriron of special strength. Adoption of these innovations in construction is to secure a lowering of capital cost, as compared to standard plants, with no sacrifice in cost of operation or maintenance.

The rake type of acid-proof Dorr classifier has been adopted in preference to the bowl type, as construction details favor the former; the plan provides that the classifiers move over and discharge the coarse ore direct into the leaching tanks. As the small percentage of slime remaining in the sand discharge of the rake classifiers caused no trouble in percolation leaching, the cleaner work of the bowl classifiers was considered unnecessary.

Iron precipitation, using baled scrap, has been adopted, at least for the first unit of the plant. Solutions will be used at atmospheric temperature. Most of the iron discard solution will be returned to the circuit, a sufficient amount being discarded to prevent undesirable accumulations of iron, which is the only impurity that will build up to an objectionable extent with this ore. Precipitation is to be conducted in wood launders on a

sloping site. The excavation is to be by gravity to settling tanks at a lower elevation. Provision will be made for drying cement copper in a mechanical drier. The precipitation launders will have the usual installation for blowing low-pressure air. The general idea of the precipitation layout is to make it 100 per cent mechanical, to obtain the greatest possible capacity and efficiency from a given cubic footage of launders installed, and to allow of frequent cleaning of "dead" iron at low cost.

The use of a very dilute sulphuric acid solution in the classifiers has been found advisable, as this effects a satisfactory extraction and simplifies the problem of washing the slime. The cost of the plant as designed to include separate slime treatment is estimated to be about 12 per cent higher than for the same tonnage treated without separation of the fines. However, it makes possible a shorter leach, as well as improved and more reliable extraction.

Metallurgical control in this process embodies some features worthy of special mention. The piping system of the plant is so designed that either the series (counter-current) system or the unit (batch) method of leaching may be employed, as well as any combination of the two. Owing to possible fluctuations in the copper value of the charges, the unit system will probably be employed. Strong acid will be added for 24 hours to the first leach solution on the ore, thereby producing a so-called "skimming" leach, which rapidly removes the easily soluble copper and makes possible longer leaching contact of the following acid solution with the more difficultly soluble copper. Strong acid is also added to the make-up solution, which follows the skimming leach, and will be recirculated over the ore for 72 hours. This solution will then be added to the new one, thus giving a certain amount of counter-current effect.

In the leaching cycle the proportions of strong acid to water will be such as to produce a pregnant solution of 5 per cent copper. A portion of the solution in the precipitation circuit will be returned to one of the make-up tanks when the copper content has been reduced to about 1 per cent. The remaining solution in the precipitation circuit will go through additional scrap-iron launders to eliminate its copper before being discarded. Carrying of relatively high copper in the precipitation circuit gives greater precipitation capacity per unit volume of the scrap-iron launders.

Carelessness Is the Chief Cause of Mine Accidents

OF ACCIDENTS in metal mines caused by falls of men, ground, and materials, the majority are probably the result of carelessness on the part of the workman and the supervising official, according to conclusions reached in an analysis of mine accidents and safety practice made by F. D. Cannon, and published as Serial 2,944, *Reports of Investigations,* U. S. Bureau of Mines. Men working in raises are given less supervision than any other class of underground employees, and these men, particularly, become careless. Safety belts, "hard-boiled" hats, safety shoes, safety leggings, goggles, and similar safety clothing reduce accidents. Guarding shafts, cages, chutes, and winzes, and properly timbering these places, are also important accident-prevention measures. Those in charge of mine management should supply such safety devices, encourage the wearing of safety clothing, and, in addition, strictly enforce safety regulations. By such methods many accidents that result from falls of men, ground, and materials may be avoided.

Pouring the first copper from the converter at Potrerillos

COMMENT AND CRITICISM

Can Africa's Railroads Carry Its Copper?

To the Editor of "E.&M.J.":

In discussing the copper districts under development in Central Africa, one of the most controversial questions, because its solution will so largely affect the success of the operating companies, is the capacity of the railroads to handle the increased freight. Some maintain that mine development and equipment will be delayed and the growth of production hampered by lack of carrying capacity, whereas others feel that facilities are adequate and that the railroads will offer no problem.

A search for facts has disclosed the following: The standard African railroad gage is 3 ft. 6 in. The maximum carload is 35 tons, and a trainload is about 300 to 350 tons of freight. Copper sent from the smelters in the Katanga usually arrives at Beira twelve to fourteen days later.

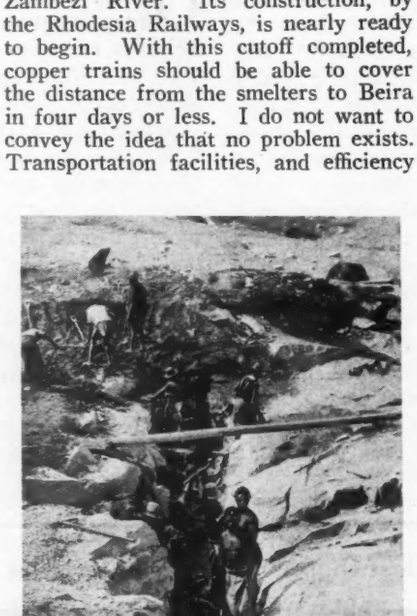
Production of Union Minière du Haut-Katanga, now at the rate of 125,000 tons annually, or 343 tons for every day in the year, is therefore keeping the equivalent of thirteen to fifteen trainloads of copper on the rails in transit constantly. That is, about one trainload is dispatched daily, and each train is on its way for the time stated.

Copper production of about five or six years hence, say 200,000 tons at Katanga and 250,000 tons from the mines in Northern Rhodesia, would mean four trains leaving daily and 56 trains going and 56 empty trains returning constantly, if this ratio were maintained. On this basis many will point out that no railroad could accommodate a volume of business which would call for 112 copper trains daily with as many more trains loaded with supplies for the copper mines, besides local freight trains and through passenger trains.

The very fact that copper shipments from Katanga to Beira, 1,455 miles, take twelve to fourteen days, however, proves in itself that it is being carried on trains that work their way through, picking up and dropping freight wherever wanted. When there is enough copper to call for a regular copper service—perhaps there is already—the distance will undoubtedly be covered in six days—probably less.

Such readjustment and speeding up will reduce the number of trains necessary to carry a given tonnage of copper by approximately one-half, relieving congestion proportionately. Returning trains will carry most of the required materials and supplies to the mines.

The distance from the copper region to Beira will be shortened by several hundred miles by the Kafue-Sinoia cutoff, the building of which necessitates another bridge across the Zambezi River. Its construction, by the Rhodesia Railways, is nearly ready to begin. With this cutoff completed, copper trains should be able to cover the distance from the smelters to Beira in four days or less. I do not want to convey the idea that no problem exists. Transportation facilities, and efficiency also, must be greatly increased. The railroad managements, however, appear to realize that carrying copper regularly in trainload lots, 1,000 to 1,500 miles, the trains returning comfortably loaded with supplies, is the best kind of business that any railroad could possibly desire.



Colored laborers at work on a construction scheme in Northern Rhodesia

One of the problems now is that of port facilities. "The port of Beira is still badly congested," the last quarterly report of Roan Antelope said, "and only the material landed recently is coming through as yet, because the earlier shipments are so buried up that they cannot be forwarded until some of the more recent accumulation of freight has been cleared away." Undoubtedly the railroad management has plans well in hand for increasing the Beira port facilities, however, as it otherwise would not be arranging to build the Kafue-Sinoia cutoff, which will bring still more freight to that port.

At the Bwana M'Kubwa meeting Sir Edmund Davis stated that the railroad rates in Rhodesia are "unduly high." As Sir Edmund is a director of the British South Africa Company, which controls the Rhodesia Railways, his remark suggests that he is in favor of reducing rates forthwith. The Rhodesia Railways and Mashonaland Railways, which has the lines that go to Beira, have in the past been white elephants on the hands of the British South Africa Company. Only since the copper developments at Katanga began have they returned reasonable profits. As they must meet further enormous expenditures immediately, the managements probably believe they are entitled to a little velvet before reducing their rates greatly, not fully realizing that to continue this policy may cause important competing lines to be built.

Sir Robert Williams is entitled to great credit for having foreseen the Central African transportation problem clearly and having the courage to build the Benguela railroad. Not so many years ago, the prevalence of opinion that the Benguela railroad would never be needed made the undertaking extremely difficult to finance. Now doubt that it will be able to handle all the traffic it will be called on to carry is being expressed.

Completed from Lobito Bay, on the West Coast, to the Angola and Belgian Congo frontier, and the extension through the Belgian Congo to a connection with the Katanga Railways in construction, the Benguela railroad will be ready in 1931 to take over a very considerable portion of Central Africa's railroad traffic. Lobito Bay is a very large and excellent natural harbor. The railroad and its connection make a short and direct line, saving about 3,000 miles on shipments of copper from Katanga to Europe.

The Benguela railroad is starting a survey of a branch line from a point in Angola to the Kansanshi mine, in Northern Rhodesia. Kansanshi is about 100 miles west of N'Changa, N'Kana, Roan Antelope, and the properties that Rhodesian Selection Trust is developing. Thus the new railroad will be headed directly toward the copper center of Northern Rhodesia, and for about half its length will be in the exclusive prospecting area controlled by Rhodesian Congo Border Concession. If this branch is connected with the Rhodesia Railways, as it undoubtedly will

be later, it will provide a still shorter route to the west coast port, Lobito Bay, for the Northern Rhodesia copper mines, and will be all in British and Portuguese territory.

Fortunately Sir Robert had devoted several years to the study and planning of African railroads before he started the work of developing the vast copper deposits at Katanga. His experience has gone into the planning and construction of the Benguela railroad, and its carrying capacity probably will be much greater than is commonly believed.

Delays will probably occur, as they invariably do when railroads are suddenly called on to serve great construction projects, but there seems little reason to fear any serious ones. The need of additional facilities will come gradually, and the railroad managements will do their best to save the situation. Traffic is being handled somehow today, and immense quantities of materials and equipment have gone into the country during the last few years without the assistance of either the Benguela railroad or the Kafue-Sinoia cutoff. The Bwana M'Kubwa plant was built, a vast construction program has been carried through by Union Minière du Haut-Katanga, all the new mining undertakings have obtained drilling and power equipment and other supplies, and in the meantime the volume of copper coming out of Katanga has increased steadily. As Central Africa's one single-tracked railroad has coped with this rapid growth of traffic, and undoubtedly its carrying capacity has been further expanded by recent experience, the new mining companies will probably be able to carry on till the added facilities of the Benguela railroad are available.

Not only has mineral wealth caused the entire area of Northern Rhodesia to be partitioned into prospecting concessions, but the agricultural resources of the great Central African plateau must also invite development. Every possible inducement exists there that railroad builders could desire. The companies already in the field evidently know this and are determined to spread themselves over it and keep it.

GEORGE L. WALKER.

London.

An Inquiry From Norway

To the Editor of "E.&M.J.":

Having available about 100,000 kw. electrical power at an ice-free harbor, at $14 per annum, I am interested in patents for developing iron- and steel-smelting industries, and manufacturing metal alloys where low-priced electric power is required. I am also interested in investing American capital in works of this kind.

Near the water-power station are large fields of magnetic iron ore (31 per cent iron). I am therefore also interested in machinery for magnetic separation and mining purposes necessary to produce a concentrate from the ore. Further, I would also be interested in manufacture of equipment for a large rolling mill in connection with steel production.

S. L. AAGENESS.

Oslo, Norway,
Kirkegt 8.

Preliminary Heating Solves Crushing Problem

To the Editor of "E.&M.J.":

The following note may be of interest in connection with an inquiry for a domestic supply of corundum, which appeared in the issue of Aug. 3.

This recalls an experience I had with corundum during the winter of 1894-95. I cannot remember the exact date, but I know the investigation was made in my old mill, which was destroyed by fire in 1906; so it is safe to say the work was done in the early nineties.

One cold winter morning a gentleman called at the mill with an express wagonload of sacked corundum ore. It was all in large pieces—nearly a ton of it. He wanted to have two of the larger pieces tested by drills. The rest he wanted crushed to 10 mesh. He said he had an entire mountain of it, but had, so far, failed to find any crusher or rolls that would stand the strain. He gave me fair warning that it would probably wreck any of the equipment I had at that time.

He gave me several days in which to prepare it. As soon as he left, its hardness was verified in both Blake and Gates crushers. The material bounded out of the jaws! The owner stated that he had been unable to find any drill adapted to it. A few days later representatives of the drill company reported that they could not drill the samples.

My mill at that time was heated by six or seven large stoves. All were fired up and half filled with the raw mineral. After being heated to a dull red heat, the mineral was thrown into iron tubs filled with snow. No decrepitation or alteration of the original material was visible. Afterward it went through the crusher and rolls as quietly as so much brown sugar, and was easily sized to 10 mesh and finer.

The entire lot was sampled, sacked, and delivered to the owner on the afternoon of the same day. He examined the samples, saying they were perfectly satisfactory, cheerfully paid $25 charges, and was greatly surprised that such a simple method had been found to meet his requirements.

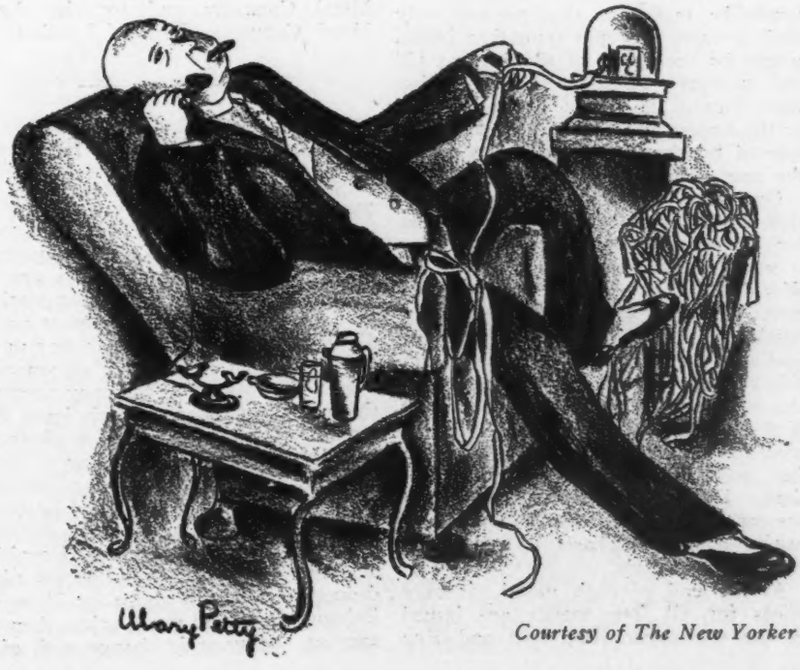
Whether the heating and sudden chilling destroyed the abrasive properties of the corundum or not I never heard or investigated. The owner politely said, "Adios, Señor" and at once left for the mine—in Argentina. So this particular supply is not a domestic one. I never heard from him again. It would be a far more difficult problem to mine such an ore than to crush it.

HENRY E. WOOD.

Berkeley, Calif.

BY THE WAY

"No, I'm very busy—I'm unloading copper"



Courtesy of The New Yorker

Consultation

Quotations of the London Metal Exchange

"Recently, in making settlement for certain foreign ores, we used the spot standard London copper quotation as published in the 'E.&M.J.,' to which our shipper took exception, stating that the figure did not agree with the official average for the month as given out by the exchange. The difference is small but is sufficient to require adjustment if the shipment is of considerable size. Will you kindly explain the reason for any difference between the London metal quotations as published in the United States, and those issued in London?"

Investigation of this subject develops the fact that there is a very real difference between published quotations of the London exchange. This metal exchange issues one set of quotations daily—namely, those based on the closing bids and offers of the morning session. For copper and tin, four quotations are issued: the cash buyers' price, cash sellers' price, three months' buyers' price, and three months' sellers' price. For lead and zinc, only two quotations are issued, a cash price and a three months' price. These lead and zinc prices are usually the last prices at which business is done at the morning session for the respective months of shipment. However, circumstances sometimes arise when a strict adherence to this rule would not give a true picture of the market values. For example, at the beginning of the session spot metal might be dealt in at £24 10s. and, simultaneously, forward at £25. The market might then rise until, at the close, forward metal might be dealt in at £25 5s., without any further business in spot, although bids and offers might be made for that position. In such a case, the spot quotation issued would be the mean of the highest bid and the lowest offer, for spot, or, if that were impossible, either the highest bid or the lowest offer, whichever was considered by the committee to be nearer the true value.

One may ask why a different practice exists for lead and zinc from that for copper and tin. The explanation is very possibly as follows: Until the World War, when the character of metal dealing changed greatly, the number of firms dealing in zinc and lead was comparatively small and outside speculative interest in those metals was not great. Therefore, if the values of these metals were indicated with less precision than those of copper and tin, the accuracy was considered sufficient. This practice has continued, but present conditions would apparently justify a uniform basis of quotations for all four metals.

At the end of each month average prices for all four metals are issued by the exchange. For lead and zinc these averages are merely the average of the daily prices for the respective positions. For copper and tin, the monthly average is arrived at by taking the mean of the cash buyers and sellers' quotations daily, respectively, and averaging.

The quotations cabled to America are identical with those issued by the exchange so far as lead and zinc are concerned. For copper and tin, however, the cash and three months' quotations are the buyers' prices, the sellers' price not being considered. Any monthly average compiled from quotations published in America, therefore, will be based on buyers' prices, whereas the English average is based on both buyers' and sellers' prices, as already mentioned, and will therefore be somewhat higher. Contracts should state definitely whether the buyers' price is to be the basis of settlement, or whether an average of the buyers' and sellers' price is to be used. The London quotations published in the *Engineering and Mining Journal* are the buyers' prices for spot and forward copper and tin, and our average is the average of these prices, respectively.

The Mining Journal, of London, publishes also the closing prices of "second 'Change"—that is, the afternoon session—but these prices are not official and are likely to be somewhat indefinite, particularly if little business is transacted. Quotations appearing in *The Mining Magazine*, we understand, have in the past been taken from the London *Times* and are erratic, sometimes being the official quotations and sometimes those of business done at the afternoon session. This will probably be remedied in the future, the afternoon quotations being ignored.

For co-operation in clearing up this matter we are indebted to the American Metal Company and to The Anglo Metal Company, Ltd., of London.

Tonopah Royalty Scale

"Please explain what is meant by the Tonopah royalty scale."

The Tonopah Belmont royalty scale amounts to 15 per cent of the net returns after deducting transportation, milling, and metallurgical losses up to $20 gross value, then 20 per cent up to $40 gross, and 25 per cent on amounts over $40 gross. The company operates the plant and charges each lease $50 monthly for equipment such as air tools, and 25c. per ton hoisting charge. Supplies are sold to leasers at cost. Leasers on the West End Consolidated property operate the plant and obtain supplies from the company at cost. Royalties amount to 20 per cent of the net after deductions as given above for Tonopah Belmont up to $20 gross value, then an average sliding scale change with each dollar value up to 26¼ per cent to $25 gross; 27 per cent up to $30 gross; 30 per cent up to $40 gross; 33 per cent up to $60 gross; 36 per cent up to $100 gross; 40 per cent up to $150 gross; 45 per cent up to $200 gross; and 50 per cent on all over $200 gross. Subleasers on West End property pay the leasers 35 per cent of the net up to $15 gross, then 40 per cent up to $20 gross; 45 per cent up to $25 gross; 50 per cent up to $50 gross; 60 per cent up to $100 gross; and 70 per cent on all amounts over $100 gross. Leasers furnish subleasers with tools and supplies except powder, fuse, caps, and labor.

Coeur d'Alene Statistics

"What are the available production figures from the Morning, Star, and Interstate mines, in the Coeur d'Alene district of Idaho?"

The information was mailed as requested, to an address in Long Island City, but the letter has been returned. The data are as follows:

The Morning mine, of Federal Mining & Smelting, has mined, from its opening in September, 1912, to Dec. 31, 1928, 4,851,537 tons of ore. Yearly average assay of the ore has ranged from 7.2 to 10.5 per cent lead, 3.6 to 7.5 per cent zinc, and 3.3 to 4.8 oz. of silver per ton. The average has been about 9.3 per cent lead, 5.6 per cent zinc, and 4.3 oz. of silver. No figures of percentage recovery of metals or of actual metal production are available. Total earnings of the mine from 1912 through 1928 are $16,364,398.

Production figures from the Star mine, owned by Hecla Mining and Bunker Hill & Sullivan, are lacking. Reports are that development work proceeded at the rate of 275 tons daily from the end of 1925 to April, 1926, and 450 tons daily until April, 1927, when work was discontinued. At the end of 1928, shipments of ore were resumed at the rate of 250 tons daily, and a report in April, 1929, was to the effect that the rate would soon be stepped up to 450 or 500 tons. Total shipments would thus appear to be about 275,000 tons of ore. Assay of the ore is not known, but it is reported to be rich in zinc and to contain small amounts of lead and silver. A large orebody has been proved, and with the recent completion of the Sullivan refining plant the Star is expected to become an important producer.

Production from the Callahan mine of Callahan Zinc-Lead, of which the Interstate mine contributed a large part, was 918,614 tons of ore, from 1913 to October, 1923, which yielded 117,964,285 lb. of lead, 386,472,612 lb. of zinc, and 2,264,903 oz. of silver. Because of the poor grade of the deposits, the mine was closed in October, 1923, and it has been idle since, although estimates have indicated that 225,000 tons of low-grade reserves still remain in the mine.

Personal Notes

Huntington Adams left New York for London on Oct. 2.

Dr. **Otto Sussman** left New York City for Europe on Sept. 27.

L. C. Penhoel, president of Southwestern Engineering, is in Joplin, Mo.

Tom Lyon, geologist for International Smelting, at Salt Lake City, is in California on professional business.

S. P. Lowe, superintendent of the new Hudson Bay Mining & Smelting mill, was recently in Salt Lake City.

Sir **Stopford Brunton,** Bart., will be at Queen's University, Kingston, Ont., during the present session, as research fellow in geology.

P. H. Brady, Jr., is in charge of development work at the reopening of the Times property in the Oatman district of Arizona.

Robert H. Bedford, mining engineer, of Grass Valley, Calif., left San Francisco on Sept. 24, for Peru and Chile, on mine examination work.

S. S. Tuthill, who resigned as secretary of the American Zinc Institute on Aug. 1, has returned to New York City after two months spent at his summer camp.

R. W. Edmonds, of Boston, Mass., and Dr. **Marshall Haney,** of Geer, Va., recently examined several manganese properties in Augusta and Rockbridge counties, Va.

Alan M. Bateman, editor of *Economic Geology*, who has been in the Northern Rhodesian and Congo copper fields in behalf of Rhodesian Selection Trust, has returned to Europe.

H. W. Gould, of San Francisco, is in New York, where he expects to meet **P. F. Berk,** of the firm of F. W. Berk & Company, Ltd., London, to discuss the quicksilver situation.

F. H. Hamilton, of London, chairman of the board of directors of the Huronian Belt Company, together with several other officials of the company, is visiting its Canadian properties.

George W. Roddewig, formerly associated with the W. A. Clark interests in Montana, has opened an office in Salt Lake City for the practice of mining engineering and geology.

M. Wallace Woolley, manager of the ore purchasing department of U. S. Smelting, Refining & Mining, returned recently to Salt Lake from a visit to Colorado and Idaho mining districts.

Richard A. Parker, mining engineer, expects to leave Denver on Oct. 5, to attend the A.I.M.E. meeting in San Francisco, after which he will sail for Japan for the World Engineering Congress.

Walker B. Carroll, formerly with the Montana Bureau of Mines, is now in charge of operations of Butte Highlands Mining, which has acquired a group of claims in the Highland district, south of Butte, Mont.

Cyril T. Young, of the department of natural resources of the Canadian National Railways, will make an examination of recent copper and gold discoveries in the Chibougamau district of northern Quebec.

Lunsford P. Yandell was elected president of Mohawk Mining at a recent company meeting, succeeding **Charles D. Lanier,** who was elected chairman of the board of directors upon his resignation from the former office.

Frank A. Forward, of Iriquois, Ont., Canada, has been appointed superintendent of the lead smelter under construction at Mount Isa, Queensland, Australia. Mr. Forward is now en route from Victoria, B. C., to take up his new duties.

FRANK A. FORWARD

W. C. Mendenhall, chief geologist of the U. S. Geological Survey, was recently in Reno, Nev., conferring with **J. A. Fulton,** director of the Mackay School of Mines, about co-operative geological work in Nevada.

Frederick Laist, metallurgical manager of Anaconda Copper Mining, recently left Anaconda to make his headquarters in New York City. As a token of the esteem in which Mr. Laist was held, his colleagues presented him with a large painting by the late Charles M. Russell, cowboy artist.

W. H. Rundall, of W. Pellew-Harvey & Company, consulting mining engineers, of London, is spending three or four weeks in the United States with the primary purpose of examining mining properties in the San Juan district of Colorado. He is accompanied by Mrs. Rundall.

Homer B. Wood has been elected the first president of the Yavapai Co-operative Prospectors' Association, an outgrowth of the mining revival held recently in Prescott, Ariz. Other officers are **Robert Robertson,** vice-president; **A. B. Noxon,** secretary; and **Mrs. R. E. Logan,** treasurer.

W. M. Cobleigh, of Bozeman, was elected president of the Montana Society of Engineers at the recent annual meeting. Other officers elected, all hailing from Butte, were: **E. V. Daveler,** first vice-president; **A. V. Corry,** second vice-president; **Lloyd Gage,** secretary; and **A. E. Adami,** treasurer.

Cornelius F. Kelley has been awarded the gold medal of the Mining and Metallurgical Society of America, "For distinguished service in the expansion and stabilization of the mining industry." The presentation will be made at a dinner to be held at the Savoy Plaza, New York City, on Oct. 22.

Van Dyne Howbert, who has been in charge of the El Paso office of American Metal for the last six years, has been transferred to the New York office of the company. **Charles E. Stott,** formerly geologist at the Presidio mine, at Shafter, Tex., is now making his headquarters at the El Paso office.

Charles R. Fettke, professor of geology at the Carnegie Institute of Technology, Pittsburgh; **W. A. Copeland,** assistant professor, and **W. H. Seifert** have completed field work on a geological survey of the Bradford oil field of northwestern Pennsylvania and adjacent parts of New York State during the last summer for the Pennsylvania Topographic and Geologic Survey, and have returned to Pittsburgh.

Scott Turner, director of the U. S. Bureau of Mines, will sail from San Francisco on Oct. 10, to attend the World Engineering Congress at Tokio. He was appointed by President Hoover as one of the five engineers who are to represent the United States government at this congress. Mr. Turner also holds a commission to represent the American Committee of the World Power Conference; he is the official delegate of the Canadian Institute of Mining and Metallurgy at the Congress; carries credentials from the University of Michigan and also the Michigan College of Mining and Technology as official representative of those two institutions at the meeting; and is listed as a member of the official party representing the A.I.M.E. He plans to return to the United States in the latter part of November.

OBITUARY

W. A. Campbell died in Winnipeg, Man., on Sept. 22, at the age of 67. He was interested in various mining enterprises in British Columbia. Since 1908 Mr. Campbell had made his home in Winnipeg.

William Alfred Paine, of Boston, president of Copper Range, operating in the Michigan copper district, and senior partner of the brokerage firm of Paine, Webber & Company, died at his home in Beach Bluffs, a suburb of Boston, on Sept. 24, after an illness of about two weeks. In 1898, Mr. Paine organized the Copper Range and affiliated companies. He was the active head of all of them.

Corrosion Combated— and How!

CORROSION is still the "enemy of industry," as it has been styled, but one that no longer has things all its way as formerly. The enemy has been getting quite a licking in the last few years, and the prospects are that from now on it will be kept on the move, falling back.

In looking backward, vision is clearer than when looking forward. The clear-sighted man perceives how foolish it was to attempt to handle corrosive mine waters and mill solutions with pumps in which the exposed parts are made of a metal that succumbs readily to these solutions. This, to borrow a simile from the zoo, is like caging a lamb with a lion and a tiger, in the manner of Barnum's famous happy family. Those who have heard this story will remember that the family got along excellently together, save that the lamb had to be renewed occasionally.

Pumping is not the only phase of operation in which corrosion is a factor, although naturally the one in which the effects of corrosive action become most apparent. Equipment of all kinds that comes in contact with corrosive waters, or that is exposed to a damp atmosphere in which ordinary rust is rapid, may deteriorate much more quickly than it would if steps were taken to prevent it.

Resisting Attack

Broadly speaking, corrosion is combated in two ways: by replacing vulnerable exposed metal with other metal or alloy or other substance that will resist corrosion; or by lining or coating the vulnerable metal with some corrosion-resisting substance.

A large number of alloys (and certain metals) having in different degrees the ability to resist the various corroding agencies encountered in industrial practice are available on the market. As complete a list of these as it has been possible to compile is appended to this article. They have been developed, or in some cases discovered, to resist the corrosive action of the commoner acids, namely, sulphuric, hydrochloric, nitric, acetic, in various strengths—and of ammonium hydroxide and alkaline solutions. Where mine water is corrosive, the presence of one or more of these agencies is ordinarily responsible.

Besides these materials, wood, rubber, porcelain, and cement are often used to resist corrosion, either as linings or actually composing the body of the part or conduit in contact with the water.

Though mine water is usually the cause of a mining company's corrosion problem (ignoring mill solutions for the moment), mine water is often not corrosive. Little trouble, for instance, is reported in the Birmingham district and in the Lake Superior iron country. In the latter region, more steel is said to be destroyed through rust than through acid action. One operator says: "A common 10-in. discharge pipe can be installed in a mine and used for twenty years at least, and if the outside action of rust be eliminated, the life of the discharge column appears to be unlimited."

Several of the northern iron companies have replaced their steel plungers with others made of porcelain, but this is to protect the packing, and to resist the wearing action of iron ore and grit in water, rather than because of acid conditions. Here the problem appears to be to find some paint or other coating to apply to steel to eliminate rust.

Other Fortunates

Likewise, in the Coeur d'Alenes the water is in general non-corrosive, although in certain upper levels near the zone of oxidation a limited amount of acidic water is developed. This, if not cared for, is destructive of pipes and rails, but, being small in quantity, is readily handled with wooden drainage boxes.

Still another operator—there are many such, of course—reports no corrosion problem in handling mine or mill waters or cyanide plant solutions. At his mine—a Western gold property—the local surface waters are simply lime-magnesia bicarbonates, with only traces of sodium chloride and sulphate, except where affected by oxidation products. The mine waters in general are similar, plus more or less sulphate, but the only samples of corrosive character have been from occasional trickles of surface water which have seeped through broken or fractured rock, and waters which were pumped out after a fire. Analyses made of the mine waters confirm the principle that the acidity of such waters decreases with increasing depth.

Luck Ends

All companies are not so fortunate. Some mines of the Michigan copper country have highly corrosive waters. One analysis has already been published in these pages (*E.&M.J.*, July 6, 1929, p. 21), together with an account of the means taken to overcome the conditions thus presented.

Further notes on the practice of other operators in various sections of the country are given in the following. Materials and means employed to prevent corrosion are described specifically, where the information has been available. In view of the existence of so many alloys and other materials from which to make selection (see Table I on pp. 553, 554, and 555), information must be specific. For this reason names of products and their manufacturers are mentioned, wherever available, in Table I and in the accompanying text.

A Bad Case

One of the largest mining companies in the country has very corrosive water in its workings. An analysis follows:

Suspended matter, Grains per U. S. gallon	16.75
Soluble solids	344.15
Silica	1.69
Fe and Al oxides	53.61
$CaSO_4$	41.04
$MgSO_4$	18.16
$CuSO_4$ (crystals)	117.84
Free H_2SO_4	133.46

This company's practice may be said to be in a state of flux, by reason of continual experimentation. Its present practice might be changed next month, if a better way were found. At the moment, it is using wood, lead, rubber, porcelain, and certain alloys with some success to resist corrosion.

In its shaft pump columns, a $\frac{3}{4}$-in. sectional wood lining has been found to last indefinitely and to be cheaper than lead. Pinhole leaks occasionally develop. Lead lining, $\frac{1}{8}$ in. thick, also used, likewise has an indefinite life. One column, in service for 26 years, is still in good condition.

For shaft drains, square wooden boxes, copper-nailed — more recently dovetailed—are employed. Experiments with hard and soft rubber linings are also in progress, the object being to prevent limonitic deposits from building up and to make cleaning easy. These linings are so constructed as to be readily removed.

In its pump plungers porcelain has been used. These plungers have been replaced in part with others of chemical stoneware at a third of the cost of porcelain. Each kind lasts indefinitely, breakage being the only serious factor. Where the water is free from grit, Corosiron (see Table I) has proved satisfactory, lasting one to two years before turning becomes necessary. In contrast, bronze plungers required turning in even 15 to 60 days, where the water was strongely corrosive.

Valve stems and disks made of Fahralloy 1635 have proved satisfactory, having a minimum life three times that of bronze. Valve seats, this operator

states, cannot readily be cast of chrome alloys, and the presence of blow holes makes their use impossible.

Pump elbows of Superascolloy, or Sweet alloy No. 17, are used, giving three times the life of bronze though costing only one-third more. Bronze lasts nine months to a year in this service. One pump manufacturer is reported to be building a centrifugal pump in which practically all parts are of this No. 17 alloy.

Bronze Cuts Waste

Another case is that of a large copper mine in the West, handling daily about 350,000 gal. of acid water, containing 0.0352 gram of copper per liter and requiring 2.845 lb. CaO per ton to neutralize it. Much trouble was had with pumps and piping, the former lasting ten months and the pipes only 6 to 8 weeks. This difficulty was overcome by using an acid-resisting bronze for the water ends of the pumps and the pipe and fittings in the pump room. After four years' use, some of it shows no ill effect. For the main water column, standard wrought-steel pipe lined with redwood staves is used. Staves and pipes were bought separately and assembled at the mine.

At a Mid-Western zinc mine all iron or steel equipment coming in direct contact with the acid mine water (containing 400-600 parts sulphuric acid per million, including both ferric and ferrous sulphate) was eaten out within a few weeks. Relief was obtained by using lead and cement-lined pumps and, in several instances, full bronze pumps, with wood and copper-steel pipe. Without these acid-resistant materials the water could not have been handled.

Conditions in a Southwestern copper mine are aggravated by the existence of burning stopes. Down to the 1,000 level, water and seepage from the surface are very acid, containing 10 lb. copper and 1 lb. free H_2SO_4 per 1,000 gal. This water is conveyed from level to level down to the 1,000 level through diamond-drill holes and then collected by concrete ditches and delivered outside via 7,000 ft. of 10-in. redwood pipe line for precipitation of the contained copper. This redwood line has been in service since 1919 and is still in good condition, although it gets plugged up at times with sediment and precipitated ferrous hydroxide.

Below the 1,000 level, the water is handled by two 500-gal. quintuplex pumps, one on 1,950 level and the other on 3,000 level. On the average, 160,000 gal. is handled daily. Although this water is not acid by analysis, precautions have been taken in case it should become so in the future. Pumps have bronze plungers, bronze-lined glands and throats, and cement-lined water ends. The cement-lined ends are less expensive than solid bronze and are said to be satisfactory. The water column is of standard 8-in. wrought-iron pipe with $\frac{1}{8}$-in. lead lining. All valves are of bronze and all fittings of extra-heavy cast iron. Although this water (below the 1,000 level) is not acid, as stated, certain fittings on pumps and pump columns become eaten and must be replaced at intervals. This action is thought to be caused by electrolysis, probably from the trolley circuits in the haulageways. It is localized to certain fittings, and to date has not been serious enough to warrant adopting some means of eliminating it.

This company has obtained some excellent results in experimenting with Rezistal 2C alloy (see Table I). A piece of it, together with a piece of boiler plate of the same size, was placed in the strongest copper solutions at its leaching plant. At the end of six days the boiler plate was completely replaced by copper, whereas the alloy showed little, if any, corrosion. At the end of a month, on cleaning and weighing, the alloy was found to have lost no weight at all.

A Condenser Problem

At another copper mine and mill in the Southwest, the mine water is slightly alkaline and corrosion gives no serious trouble. Nevertheless, the company intends in the future to use copper steel in as much of its equipment as possible (ore cars, piping, and complementary equipment) to reduce depreciation through rust. In its mill circulation system, trouble is had from a scale which builds up in the pipe lines. The water used here is either naturally alkaline or becomes so after treatment with excess of slaked lime emulsion. Trouble is also experienced in the condenser circulating water at the power plant from the corrosion of steel pipes, condenser tubes, and even the cast-iron doors of the condenser shell. The condenser water is corrosive, not only to the steel pipes but also to the condenser tubes when made of any alloy of copper and zinc, and copper condenser tubes are therefore used. This circulating water is usually alkaline, and no reason has been found for its corrosive effect on steel piping.

At still another copper mine and mill in the Southwest, the water handled

(Continued on page 556)

Table I. Data on Corrosion-Resisting Materials and Alloys

Excerpted from table published as supplement to September issue (1929) of "Chemical and Metallurgical Engineering"

Material	Manufacturer	Essential Nominal Chemical Composition Per Cent (See Footnote (a) on p. 555)	Physical Properties: Machine Qualities	Physical Properties: Abrasion Resistance	Corrosion Data (See Footnote (b) on p. 555): Sulphuric Acid: Temp. F.	Sulphuric Acid 0.5%	Sulphuric Acid 2.5%	Sulphuric Acid 10%	Sulphuric Acid 25%	Ammonium Hydroxide 10%	Ammonium Hydroxide Conc.	Moist Sulphurous Atmos.	Mine Water
METALS													
Aluminum 2S	Aluminum Co. of Am., Pittsburgh, Pa.	Al, 99.2 (Al, 99.9+available)	Good		Room	R	R	R		R	R	•	•
Armco Ingot Iron	Amer. Rolling Mills Co., Middletown, Ohio	Fe; S, 0.025; Mn, 0.017; C, 0.012; P, 0.005	Good		Room	R							R
Chemical Lead	National Lead Co., New York, N. Y.	Pb, 99.93; Cu, 0.08	Fair		Room 158 212	R R R	R R R	R R R		R R	R R	R	R
Deoxidized Copper	Amer. Brass Co., Waterbury, Conn.	Cu, 99.90+; P, 0.01	Good		Offers fair resistance to dilute solutions.							R	•
Deoxidized Copper	Chase Brass & Copper Co., Waterbury, Conn.	Cu, 99.9+	Poor		Room 158	R R	R					R	R*
Genuine Wrought Iron	Reading Iron Co., Reading, Pa.	Fe, 98.5	Good		Room, Recommended for 95% acid. 158, Recommended for 95% acid					R R	R R		R
Nickel	International Nickel Co., New York, N. Y.	Ni (+Co), 99-99.95; C, 1-0.25; Si, 1-0.25; Mn, 1-0.3; Fe, 1-0.55; Cu, 1-0.25	Satisfactory	R	Corrosion rate depends on exposure conditions and type of apparatus. Used in special cases to replace cheaper material.					Where special properties make advantageous.			
Tantalum	Fansteel Products Co., North Chicago, Ill.	Ta, 99.5	Good	R	Room 158	R R	R R	R R	R R	R R	R R	R	R
NON-FERROUS ALLOYS													
Admiralty	Chase Brass & Copper Co., Waterbury, Conn.	Cu, 70; Zn, 29; Sn, 1	Fair		Room	R R	R					R	R*
Adnic	Scovill Manufacturing Co., Waterbury, Conn.	Cu, 70; Ni, 29; Sn, 1	Good										
Alclad 17 ST	Aluminum Co. of Am., Pittsburgh, Pa.	Al; 94; Cu, 4; Mg, 0.5; Mn, 0.5; coated with Al, 99.7+											
Aluminum Alloy 3S	Aluminum Co. of Am., Pittsburgh, Pa.	Al, 98; Mn, 1.25	Good		Room Substantially same corrosion resistance as pure aluminum.	R	R	R		R	R	•	
Aluminum Bronze	Amer. Brass Co., Waterbury, Conn.	Cu, 88-96.1; Al, 2.3-10.5; Fe Sn	Good	R	Offers good resistance to dilute hot or cold solutions.							R*	•
Aluminum-Silicon	Aluminum Co. of Am., Pittsburgh, Pa.	Al, 95; Si, 5	Fair		Good resistance to atmospheric attack inland and near salt water.								
Ambrac A	Amer. Brass Co., Waterbury, Conn.	Cu, 75; Ni, 20; Zn, 5	Good		Offers good resistance in cold up to 95%, to hot up to 50% in absence of oxidizing agents.							Fair resistance	•

Material	Manufacturer	Essential Nominal Chemical Composition Per Cent (See Footnote (a) on p. 555)	Physical Properties: Machine Qualities	Physical Properties: Abrasion Resistance	Corrosion Data (See Footnote (b) on p 555): Sulphuric Acid: Temp. F.	Sulphuric Acid: 0.5%	Sulphuric Acid: 2.5%	Sulphuric Acid: 10%	Sulphuric Acid: 25%	Ammonium Hydroxide: 10%	Ammonium Hydroxide: Conc.	Moist Sulphurous Atmos.	Mine Water
Antimonial Lead	National Lead Co., New York, N. Y.	Pb, 92-94; Sb, 6-8	Good		Room	R	R	R	R	R	R	R	R
					212	R	R	R	R	R	R		
Barberite	Barber Asphalt Co., Philadelphia, Pa.	Cu, 88.5; Ni, 5; Sn, 5; Si, 1.5	Good		Room	R	R	R	R			R	R
					158	R	R	R	R				
Commercial Bronze	Chase Brass & Copper Co., Waterbury, Conn.	Cu, 90; Zn, 10	Poor		Room	R	R						
					158	R						R	R*
Everdur	Amer. Brass Co., Waterbury, Conn.	Cu, 94.8-96; Si, 3-4; Mn, 1-1.2	Good		Offers good resistance in cold up to 95%, to hot up to 50% in absence of oxidizing agents.							R	*
Fahralloy F1	Southern Manganese Steel Co., St. Louis	Ni, 34-36; Cr, 15-17; C, less than 1	Good		Room	R	R	R	R	R	R	R	R
					212	R	R	R	R	R	R	R	R
Fahralloy F3	Southern Manganese Steel Co., St. Louis	Ni, 2-4; Cr. 26-28; C, greater than 1	Good	R	Room	R	R	R	R	R	R	R	R
					212	R	R	R	R	R	R	R	R
Hardware Bronze	Chase Brass & Copper Co., Waterbury, Conn.	Cu, 89; Zn, 9; Pb, 2	Good		Room	R	R						
					158	R						R	R*
Hastelloy D	Haynes Stellite Co., Kokomo, Ind.	Ni, 90; Cu, 3; Al, 1.5; Si, 10±	Difficult		Room	R	R	R	R	R	R	R	R
					158	R	R	R	R	R	R		
Hytensl Bronze	Am. Manganese Bronze Co., Philadelphia, Pa.	Cu, 60; Zn, 19; Al, 10; Fe, 6; Mn, 5	Same as mild steel	R									
Illium G	Burgess-Parr Co., Moline, Ill.	Ni, 60; Cr, 25; Cu, 7	Machinable	R	Room	R	R	R	R	R	R	R	R
					100	R	R	R	R	R	R		
Monel Metal	International Nickel Co., New York, N. Y.	Ni, 60-70; Cu, 25-35; Fe, 1-3; Mn, 0.25-2; Si, 0.02-1.5; C, 0.5-.3	Satisfactory	R	Corrosion rate depends on exposure conditions and type of apparatus. Extensively used in textile and chemical industries against sulphuric acid.*d*					Advantageous.		With caution	With caution,*e*
Nichrome IV	Driver-Harris Co., Harrison, N. J.	Ni, 80; Cr, 20	Good										
Nickel Silver 18% A	Riverside Metal Co., Riverside, N. J.	Cu, 65; Ni, 18; Zn, 17	Good	R	Room	R	R	R					
					158	R*	R*	R*				R	*
Nickel Silver 18% B	Riverside Metal Co., Riverside, N. J.	Cu, 55; Ni, 18; Zn, 27	Good	R	Room	R	R	R					
					158	R*	R*	R*				R	*
Phosphor Bronze 30	Riverside Metal Co., Riverside, N. J.	Cu, 95.5; Sn, 4.3; P, 0.2	Good	R	Room	R	R	R	R				
					158	R*	R*	R*				R	R
Phosphor Bronze 47	Riverside Metal Co., Riverside, N. J.	Cu, 91.6; Sn, 8.25; P, 0.15	Good	R	Room	R	R	R	R				
					158	R*	R*	R*				R	R
Phosphor Bronze 209	Riverside Metal Co., Riverside, N. J.	Cu, 90; Sn, 10; P, Trace	Good	R	Room	R	R	R	R				
					158	R	R	R	R			R	R
Red Brass	Amer. Brass Co., Waterbury, Conn.	Cu, 85; Zn, 15	Good		Offers good resistance to dilute solutions.							R	*
Red Brass	Chase Brass & Copper Co., Waterbury, Conn.	Cu, 85; Zn, 15	Poor		Room	R	R						
					158	R						R	R*
Resistac	Am. Manganese Bronze Co., Philadelphia, Pa.	Cu, 90; Al, 9; Fe, 1	Good	R	Room	R	R		R				
Stellite	Haynes Stellite Co., Kokomo, Ind.	Co, 40-80; W, 0-25; Cr, 20-35; C, 0.75-2.5	Not machinable	R						R	R		R
										R	R		
Tophet A	Gilby Wire Co., Newark, N. J.	Ni, 80; Cr, 20	Tough										R
FERROUS ALLOYS													
Allegheny Metal	Allegheny St. Co., Brackenridge, Pa.	Fe; Cr, 17-20; Ni, 7-10; Mn, <0.5; Si, <0.5; C, <0.2	Machinable							R	R		
										R	R	R	R
Ampco Metal	Amer. Metal Products Co., Milwaukee, Wis.	Cu, 80-90; Al, 8-10; Fe, 6-7	Good		Room	R	R	R					
					194			R					
Ascoloy 33	Allegheny Steel Co., Brackenridge, Pa.	Fe; Cr, 12-16; Ni, <0.5; Si, <.05; Mn, <0.5; C, <0.12	Good	R						R	R		
										R	R		R
Ascoloy 44	Allegheny Steel Co., Brackenridge, Pa.	Fe; Cr, 22-25; Ni, 10-13; Mn, <1; Si, <0.5; C, <0.2	Machinable	Fair						R	R		
										R	R	R	R
Ascoloy 55	Allegheny Steel Co., Brackenridge, Pa.	Fe; Cr, 26-30; Mn, <1; Ni, <0.6; Si, <0.6; C, <0.25								R	R		
										R	R		R
Ascoloy 66	Allegheny Steel Co., Brackenridge, Pa.	Fe, Cr, 16-19; Mn, <0.5; Ni; <0.5; Si, <0.5; C, <0.12								R	R		
										R	R		
Carpenter Stainless Steel 1	Carpenter Steel Co., Reading, Pa.	Fe; Cr, 12-14; C, 0.1	Good	R	Resists corrosion of mine water and ammonia.							R	
Carpenter Stainless Steel 2	Carpenter Steel Co. Reading, Pa.	Fe; Cr, 12-14; C, 0.3	Good	R	Resists corrosion of mine water, ammonia and alkaline solutions§								R
Carpenter Stainless Steel 3	Carpenter Steel Co., Reading, Pa.	Fe; Cr, 20; Cu, 1; C, 0.3	Good	R	Resists corrosion of mine water, ammonia and alkaline solutions.§								R
Carpenter Stainless Steel 4	Carpenter Steel Co. Reading, Pa.	Fe; Cr, 18; Ni, 9.5; C, 0.1	Fair	R	Resists corrosion of organic and inorganic materials except, HCl, HF, Br and I.§							R	R
Carpenter Stainless Steel 5	Carpenter Steel Co., Reading, Pa.	Fe; Cr, 14; Zr S, 0.4; C, 0.1	Good	R	Resists corrosion of mine water, ammonia and alkaline solutions.§								R
Chromax Castings	Driver-Harris Co., Harrison, N. J.	Fe; Ni, 35; Cr, 15	Good										
Cristite 1	Commercial Alloys Co., San Francisco, Calif.	Fe, 66; W, 17; Cr, 10; C, 3.5; Mo, 2.5	Not machinable	R	Room					R	R		R
Crocar	Vanadium Alloys St. Co., Latrobe, Pa.	Fe; Cr, 12; C, 2.15; V, 0.75; Co, 0.75	Fair	R									
Cyclops 17 Metal	Cyclops Steel Co., Titusville, Pa.	Fe; Ni, 20; Cr, 8; Mn, 0.75; C, 0.4	Good	R	Room	R				R	R		
					158	R				R	R	R	
Defiheat Rustless Iron	Rustless Iron Corp. of Am., Baltimore, Md.	Fe; Cr, 25-30; Mn, <0.5; C, 0.25; Ni, Trace								R	R		
										R	R	R	
Defirust Rustless Iron	Rustless Iron Corp. of Am., Baltimore, Md.	Fe; Cr, 12-14; Mn, <0.5; C, <0.1; Ni, Trace	Good	R	Room					R	R		
					158					R	R		
Defistain Rustless Iron	Rustless Iron Corp. of Am., Baltimore, Md.	Fe; Cr, 17-19; Ni, 7-10; Mn, <.50; C, 0.2	Good	R						R	R		
										R	R	R	R
Delhi Hard	Ludlum Steel Co., Watervliet, N. Y.	Fe; Cr, 16.5-18; C, 1-1.1; Si, 0.75-1; Mn, 0.35-0.5	Good							R	R	R	R
Duraloy A	Duraloy Co., Pittsburgh, Pa.	Fe; Cr, 27-30; Mn, 0.5; C	Good	R						R	R		
										R	R	R	R
Duraloy B	Duraloy Co., Pittsburgh, Pa.	Fe; Cr, 16-18; Mn, <0.5; C								R	R		
										R	R	R	
Duraloy 18-8	Duraloy Co., Pittsburgh, Pa.	Fe; Cr, 18; Ni, 9; Mn, 0.5; C	Good							R	R		
										R	R	R	
Durimet B	Duriron Co., Dayton, Ohio	Fe; Ni, 35; Cr, 12; Si, 5; C, 0.25	Good		Room	R	R	R	R	R	R		
					158	R	R	R	R	R	R	R	R
Durimet A	Duriron Co., Dayton, Ohio	Fe; Ni, 25; Si, 5; C, 0.25	Good		Room	R	R	R	R	R	R	R	R
					158	R	R	R	R	R	R		
Durimet D	Duriron Co., Dayton, Ohio	Fe; Ni, 15; Cr, 2.5; Si, 3; C, 0.6	Good		Room	R	R	R	R	R	R		
					158	R	R	R	R	R	R	R	R
Duriron	Duriron Co., Dayton, Ohio	Fe; Si 14.5; C, 0.85; Mn, 0.35	Not machinable	R	Room	R	R	R	R	R	R		
					158	R	R	R	R	R	R	R	R
Elcomet	La Bour Co., Incorp., Elkhart, Ind.	Nickel-Chromium Steel Alloy of high silicon content	Good	R	Room	R	R	R	R	R	R		
					158	R	R	R	R	R	R	R	R
Enduro A	Central Alloy St. Co., Massillon, Ohio	Fe; Cr, 16.5-18.5; Mn, 0.5 max.; Si, 0.5-1.25 max.; Ni, 0.25 max.; C, 0.1 max.	Fair		Room					R	R		
					158					R	R	R	R
Enduro A	Ludlum Steel Co., Watervliet, N. Y.	Fe; Cr, 16.5-18.5; Si, 0.75; C, 0.1 max.	Good									R	R
Enduro KA2	Central Alloy St. Corp., Ludlum Steel Co., Babcock & Wilcox Tube Co., New York, N. Y.	Fe; Cr, 16.5-19.5; Ni, 7-10; Si, 0.75 max.; Mn, 0.5 max.; C, 0.15 max.										R	R
Enduro KM1	Ludlum Steel Co., Watervliet, N. Y.	Fe; Cr, 13-14; Ni, 2 max.; Mn, 0.3-0.6; C, 0.12 max.											R
Enduro S	Central Alloy St. Co. Massillon, Ohio	Fe; Cr, 14.5-15.5; Mn, 0.5 max.; Si, 0.5 max.; Ni, .25; C, .05-.12	Good							R	R		
										R	R	R	R

Material	Manufacturer	Essential Nominal Chemical Composition Per Cent (See Footnote (a) on p. 555)	Physical Properties: Machine Qualities	Physical Properties: Abrasion Resistance	Corrosion Data (See Footnote (b) on p. 555): Sulphuric Acid: Temp. F.	Sulphuric Acid: 0.5%	Sulphuric Acid: 2.5%	Sulphuric Acid: 10%	Sulphuric Acid: 25%	Ammonium Hydroxide: 10%	Ammonium Hydroxide: Conc.	Moist Sulphurous: Atmos.	Mine Water
Enduro S15	Central Alloy St. Co., Massillon, Ohio	Fe; Cr, 12.5–14.5; Mn, 0.5 max.; Si, 0.5 max.; Ni, 0.5 min.; C, 0.12–0.18	Fair							R R	R R	R	R
Firearmor	Mich. Products Corp., Mich. City, Ind.	Ni, 60; Cr. 20; Fe, 10; Mn, 1.75; C, 0.5	Good	R									
Hastelloy A	Haynes Stellite Co., Kokomo, Ind.	Ni, 60; Fe, 20; Mo, 20	Good		Room 158	R R	R R	R R	R R	R R	R R	R	R
Hastelloy C	Haynes Stellite Co. Kokomo, Ind.	Fe; Mo; Ni	Good		Room 158	R R	R R	R R	R R	R R	R R	R	R
Konel	Westinghouse Research Labs., Pittsburgh, Pa.	Ni, 73; Co, 17.5; Fe, 6.5; Ti, 2.5, Mn, 0.2											
Meehanite Metal	Ross-Meehan Foundries, Chattanooga, Tenn.	Fe; C, 2–3; Si, 1–24; P, 0.1; S, 0.04–0.14	Good	R									
Midvale ATV1	Midvale, Co., Philadelphia, Pa.	Fe; Ni, 33–39; Cr, 10–12; Mn, 1.1–1.8; C, 0.25–0.35	Good										
Midvale ATV3	Midvale Co., Philadelphia, Pa.	Fe; Ni, 25–28; Cr, 13–15; W, 3–4; Mn, 1–1.5; C, 0.4–0.5	Good										
Midvale BTG	Midvale Co., Philadelphia, Pa.	Fe; Ni, 60–62; Cr, 10–11; W, 2–2.5.; Mn, 1.2–1.5; C, 0.3–0.35	Good										
Midvale HR	Midvale Co., Philadelphia, Pa.	Fe; Cr, 20; Ni, 7; W, 4; C, 0.35; Mn, 0.5	Machinable										
Midvale V$_2$A	Midvale, Co., Philadelphia, Pa.	Fe; Cr, 17–19; Ni, 8–9; Mn, <0.5; C, 0.06–0.25	Machinable									R	R
Misco C	Mich. Steel Casting Co., Detroit, Mich.	Fe; Cr, 28–30; Ni, 8–10; Si, 1.5; C, 0.5–0.7; Mn, 0.4–0.5	Fair	R									
Nichrome	Driver-Harris Co., Harrison, N. J.	Ni, 60; Fe, 24; Cr, 16; C, 0.1											
Nichrome Castings	Driver-Harris Co., Harrison, N. J.	Ni, 60; Fe, 25; Cr, 15; C, 0.7			Room 158	R R	R R	R R	R R			R	R
Pyrasteel	Chicago St. Fdry. Co., Chicago, Ill.	Fe, 57; Ni, 25; Cr, 15; C, 0.3	Fair										
Rezistal 4	Crucible Steel Co. of Am., New York, N. Y.	Fe; Ni, 24–26; Cr, 17–18; Si, 2.5; C, 0.15–0.25	Fair							R R	R R		R
Rezistal 7	Crucible Steel Co. of Am., New York, N. Y.	Fe; Cr, 25–26; Ni, 19–21; Si, 2–3; C, 0.2	Machinable										
Rezistal 2C	Crucible Steel Co. of Am., New York, N. Y.	Fe; Cr, 17.5–19; Ni, 8–9; Si, 2–2.5; C, 0.1–0.2	Fair							R R	R R	R	R
Rezistal 255C	Crucible Steel Co. of Am., New York, N. Y.	Fe; Ni, 24–26; Cr, 10–12; Si, 4.5–5.5; C, 0.15	Good		Room 158	R R	R R	R R	R R	R R	R R		
Rezistal 355C	Crucible Steel Co., of Am., New York, N. Y.	Fe; Ni, 34–36; Cr, 10–12; Si, 4.5–5.5; C, 0.15	Good		Room 158	R R	R R	R R	R R	R R	R R		
Rezistal KA2	Crucible Steel Co. of Am., New York, N. Y.	Fe; Cr, 17.5–19; Ni, 8–9; Mn, 0.5; C, 0.15 max.	Fair							R R	R R	R	R
Rol-Man Manganese Steel	Manganese St. Forge Co., Philadelphia, Pa.	Fe; Mn, 11–14; C, 1–1.3	Machinable	R									
Special Defirust Rustless Iron	Rustless Iron Corp. of Am., Baltimore, Md.	Fe; Cr, 16–18; Mn, <0.5; C, <0.1; Ni, trace	Good	R						R R	R R	R	
Stainless A	Colonial Steel Co., Pittsburgh, Pa. Vanadium-Alloys St. Co., Latrobe, Pa.	Fe; Cr, 14; C, 0.35	Fair							R R	R R		R
Stainless B	Colonial Steel Co., Pittsburgh, Pa. Vanadium-Alloys St. Co., Latrobe, Pa.	Fe; Cr, 16.5; C, 0.65	Good							R R	R R		
Stainless 1	Colonial Steel Co., Pittsburgh, Pa.	Fe; Cr, 13.5; C, 0.1	Poor							R R	R R		R
Stainless N	Colonial Steel Co., Pittsburgh, Pa.	Fe; Cr, 18; Ni, 8; C, 0.18	Good							R R	R R	R	R
Stainless U	Colonial Steel Co., Pittsburgh, Pa.	Fe; Cr, 19; Ni, 9; Cu, 1; Mo, 1; C, 0.2	Good		Room 158	R R	R R	R R	R R	R	R	R	R
Stainless Iron	Amer. Stainless Steel Co., Pittsburgh, Pa.	Fe; Cr, 8 and over; Mn, 0.4; C, <0.12	Good	R						R R	R R		R
Stainless Iron	D. Colville & Sons, Ltd. Glasgow, Scotland	Fe; Cr, 16–17; Mn, 0.4; C, 0.1 max.	Good							R R	R R		R
Stainless Iron	Midvale, Co., Philadelphia, Pa.	Fe, 85–89; Cr, 10–14; Mn, <0.5; C, <0.13	Fair	R						R		R	R
Stainless Steel	Amer. Stainless Steel Co., Pittsburgh, Pa.	Fe; Cr, 8 and over; Mn, 0.4; C, <0.12	Good	R						R R	R R	R	R
Stainless Steel	Midvale Co., Philadelphia, Pa.	Fe; Cr, 10 or more; Mn, <0.5; C, 0.25 or more	Good							R R	R R		
Standard Misco	Mich. Steel Casting Co., Detroit, Mich.	Fe; Ni, 35–37; Cr. 15–17; Si, 1.4–1.6; Mn, 0.6–0.8; C, 0.5–0.7	Fair	R									
Sterling Nirosta Steel	Firth-Sterling St. Co., McKeesport, Pa.	Fe; Cr, 18; Ni, 8; Mn, 0.35; C, 0.15	Fair		Room 158	R R	R R	R R	R R	R R	R R	R	R
Sterling Stainless Steel A	Firth-Sterling St. Co., McKeesport, Pa.	Fe; Cr, 13.5; Mn, 0.35; C, 0.35	Good	R						R R	R R		R
Sterling Stainless Steel B	Firth-Sterling St. Co., McKeesport, Pa.	Fe; Cr, 16.5; C, 0.65; Mn, 0.35	Good	R						R R	R R		R
Sterling Stainless Steel T	Firth-Sterling St. Co., McKeesport, Pa.	Fe; Cr, 12.5; Mn, 0.35; Ni, 0.35; C, 0.12	Good	R						R R	R R		R
Sweetaloy 16	W. J. Sweet Fdry. Co., Irvington, N. J.	Fe, 82; Cr, 16–18; Mn, 0.5; Ni, 0.5; C, 0.35	Good	R						R	R		R
Sweetaloy 17	W. J. Sweet Fdry. Co., Irvington, N. J.	Fe, 69; Cr, 18–20; Ni, 8–10; Mn, 0.5; C, 0.15	Good	R						R	R	R	R
Sweetaloy 18	W. J. Sweet Fdry. Co., Irvington, N. J.	Fe, 67; Ni, 22; Cr, 10; Mn, 0.5; C, 0.2	Good	R	Room 158			R R					
Sweetaloy 19	W. J. Sweet Fdry. Co., Irvington, N. J.	Fe, 70; Cr, 28; Mn, 0.5; Ni, 0.5; C, 0.5	Good	R						R	R		R
Sweetaloy 20	W. J. Sweet Fdry. Co., Irvington, N. J.	Fe, 45; Ni, 36; Cr, 18; Mn, 0.5; C, 0.3	Good		Room 158	R R	R R	R R					R
Sweetaloy 22	W. J. Sweet Fdry. Co., Irvington, N. J.	Fe, 60; Cr, 28; Ni, 10; Mn, 0.5; C, 0.35	Good	R						R	R	R	R
Tantiron	Bethlehem Fdry. & Mach. Co., Bethlehem, Pa.	Fe, 84.87; Si, 13.5; C, 1; Mn, 0.4; P, 0.18; S, 0.05	Not machinable	R	Room 158	R R	R R	R R	R R	R R	R R	R	R
Toncan Copper Molybdenum Iron	Central Alloy St. Corp., Massillon, Ohio	Fe; Cu, 0.45; Mo, 0.07; C, 0.03	Tough							R R	R R	R	R
Tophet C	Gilby Wire Co., Newark, N. J.	Ni, 60; Cr, 12; Fe	Tough							R R	R R		R
Zorite	Mich. Products Corp., Mich. City, Ind.	Ni, 35; Fe, 17; Cr, 15; Mn, 1.75; C, 0.5	Good	R									

a—"Essential nominal chemical composition" refers to the principal elements and the approximate proportion present in a typical alloy. When "Fe" is shown without percentage it may be assumed that it represents the balance of the composition.

b—Corrosion Data.—R = Recommended by manufacturer for conditions of concentration and temperature specified. Where space is left blank the material is either not recommended by the manufacturer or sufficient information on which to base a recommendation was not available.

*—In use under these conditions but cannot make general recommendations without knowledge of service required.

d—Depending upon conditions of exposure the corrosion rate for Monel metal in dilute sulphuric acid is 0–500 m.d.d.; in acetic acid is 0–1,100 m.d.d.; in sodium hydroxide is 0–3 m.d.d.; and in ammonium hydroxide is 0–100 m.d.d.

e—See McKay, Chem. & Met., Feb. 11, 1924.

§—Recommended customer test under his own conditions.

(Continued from page 553)

varies from slightly corrosive mine water to highly corrosive leaching solution, one analysis of which is as follows:

	Grams per Liter
Ferrous iron	0.513
Ferric iron	2.386
Acidity, H_2SO_4	0.596
Copper	1.774

If standard material, such as cast iron and steel, is used for pumps and piping, constant trouble and expense are inevitable, except with the very slightly acid mine waters, where cast iron will give fairly long life. Special material and construction are used for handling all corrosive waters, as follows:

For high-head pumping installations handling very corrosive water, acid-proof bronze-water-end plunger pumps are used with plungers either of acid-proof bronze or porcelain, the latter being preferable. Pump column and piping consists of wood-lined steel pipe. Lead-lined steel pipe is preferable because there is less chance of leakage and corrosion at flange joints, but the extra expense apparently is not justified on large-capacity piping.

For low-head highly corrosive waters and solutions such as are used in mill and leaching plant, Duro iron or antimonial-lead pumping units are used; also, lead- or wood-lined steel pipe, or in many installations wood pipe.

In the last two years experiments have been made with valve stems and various pump parts of stainless steel; also with various chrome alloys, all with excellent results; and with acid-proof bronzes of the company's own make, so as to obtain a bronze suitable for the various corrosive waters and one of uniform composition.

In the Northwest a copper mine has little trouble with corrosive mine waters, although other mines in the vicinity have considerable. The main pump column has redwood lining and gives excellent service. Bronze pump plungers are used. Conditions at this mine are mild, however, and are not representative of the average in the district.

The water of a copper mine in the South contains 125 parts sulphurous acid per million. Bronze pumps and extra-heavy cast-iron water columns are used. These columns last seven to ten years. Nickel-steel fittings are provided in some cases on the pumps.

In conclusion, the words of the chiet engineer of one of the largest of these companies are worth repeating. He says:

"If acid water is to be handled for any length of time, the extra expense of acid-proof equipment is always justified and will show a good saving, especially on equipment that must maintain continuous operation, as the actual extra cost of acid-proof equipment is generally small compared with the expense of lost time due to repairs and replacements of corroded equipment. An instance of this was brought to my attention a few weeks ago where a mining company installed a single pump column of steel pipe without lining, which is badly corroded after a year of service, and the company is in the position of installing a new pump column or letting the mine flood and putting a lining in the present column, either of which remedies means many thousand dollars more than the cost of lining this pipe

The data in the accompanying table have been excerpted from a much larger table published as a supplement to the September issue of *Chemical and Metallurgical Engineering.* A. H. H.

Digest of Current Literature

Electrolytic Nickel. K. M. Oesterle. *Zeitschrift fur Elektrochemie.* August, 1929. A study has been made of the effect of nickel hydroxide, formed by reason of discharge of hydrogen ions, on the form in which nickel is deposited. For this purpose very thin films were deposited from electrolytes in which *pH* and other conditions were precisely controlled. These deposits were examined for their magnetizing behavior, spontaneous contraction, and electromotive behavior. In a pure normal solution of nickel chloride, with nothing added except acetate buffer, at low *pH* values the deposit is pure glossy nickel. As *pH* increases, up to 4.5, the grain structure becomes finer, but no oxide or hydroxide precipitation takes place except possibly as a colloidal or flocculated turbidity in the electrolyte. When the *pH* exceeds 4.5, a greenish coating appears on the cathode; at 6.0 deposition of metal is entirely displaced by the gradually increasing predominance of hydroxide formation. With small additions of a protective colloid—for example, gelatin—a smooth metal deposit, with violet to brownish gloss, is obtained below a *pH* of 4.5. The gelatin acts as a protective colloid for the nickel hydroxide, and does not itself enter into the metal deposit. Ammonium chloride has an effect similar to that of gelatin, though other agents giving an equivalent *pH* lowering do not. Apparently ammonia complexes of nickel ions are involved. The aim in electrolytic deposition of nickel is to obtain a coherent layer of fine crystalline particles, which is best effected at a fairly high temperature in a rather acid solution. But these conditions also encourage formation of nickel hydroxide; hence, precise control is necessary. Results of this study are confirmed by X-ray spectrographic studies. Curves and tables of data are given.

Grinding Mills. By John Gross and S. R. Zimmerley. U. S. Bureau of Mines Investigation. Serial 2952. A method is described whereby surface figures are obtained on a ground ore by comparison with determined values for quartz and by application of correction factors for density and for irregularity of particles. These figures are given for galena, sphalerite, and pyrite. Sampling of the grinding circuits in the mills is described, and the tonnage calculations therefrom are given. The accuracy of these figures is given in tonnage balances. Sizing and elutriation figures are presented with the analyses of the sized products. Sizing balances and mineral balances are calculated as a means of checking the reliability of the data. Classifier efficiencies on the various sizes of each mineral are given that show a decreased efficiency on the minerals of higher density, resulting in a circulating load containing a large amount of the heavier minerals sufficiently fine for treatment. Increased fineness of the minus 200 mesh due to its passage through the mills is shown. Surface figures for the various sizes of all minerals in all samples are given, and a surface balance on the classifiers shows a close agreement. Grinding efficiency figures are calculated for the mills after allowing for the crushing resistance of the various minerals. These efficiencies show a rather high total efficiency in the mills when compared with figures obtained in the laboratory, but show an extraordinarily large percentage of work going to useless grinding. The study of recovery in subsieve sizes is shown to be possible by the elutriation of minus 200-mesh material, from which the critical size for optimum recovery is obtained.

Poling Copper. P. Siebe. *Metall und Erz.* August, second number, 1929. In the refining of copper in a flame furnace, the principal physical changes occur during the poling process. Measurements are reported of the changes in density and in electrical conductivity during poling. Some experiments in over-poling are included, since over-poling is the principal cause of unsatisfactory results in this part of the refining. Results of previous investigators, who found a considerable drop in density toward the end of the poling, were fully confirmed. The decrease is caused by gas absorption, and becomes quite rapid in the over-poling range. Impurities in the copper tend to decrease the gas absorption, cuprous oxide being particularly active in this respect. Over-poling has also a noteworthy effect on electrical conductivity. First, a sharper rise occurs than is observed prior to the over-poling stage; finally, at the last degree of over-poling, a slight decrease in the conductivity takes place. Experimental results are shown in tables and curves. The cause of the increasing electrical conductivity is that the poling lessens the content of cuprous oxide inclusions, the oxide being a poorer conductor than the metal. The changes in density and conductivity, like the previously known changes in structure and surface properties, reflect a decrease in quality as the optimum poling treatment is exceeded. The lowering in electrical conductivity is not in itself particularly significant, because it begins at an extreme of poling not occurring in practice; the density decrease is more significant. Especially worthy of note is the fact that as the harm caused by excessive poling is greater, the greater is the purity of the copper being refined, because gas absorption is favored in the purer copper.

NEWS OF THE WEEK

Summary

CONSTRUCTION work is the chief activity now at Flin Flon and Sherritt-Gordon, northern Manitoba's two most important developing mines. Estimates show probable output of 57,000,000 lb. of copper and 75,000,000 lb. of zinc annually. Page 560.

* * *

Drilling at the Pecos mine of American Metal, near Santa Fe, N. M., has disclosed a new orebody below the 800 level and south of the main shaft, which will be deepened to permit development. Page 558.

* * *

A new drainage tunnel is being driven to serve the Chorolque Mountain property of Aramayo Mines, in Bolivia. Exploitation of an alluvial tin deposit may be a result of the additional water made available. Page 559.

* * *

Universal Exploration, a subsidiary of U. S. Steel, is building an 800-ton flotation plant in the Jefferson City district of Tennessee. Production will start next year. Page 559.

* * *

Construction of a sulphuric acid plant has been started in the Sudbury district by Canadian Industries. Niter cake will be supplied to International Nickel. Page 558.

* * *

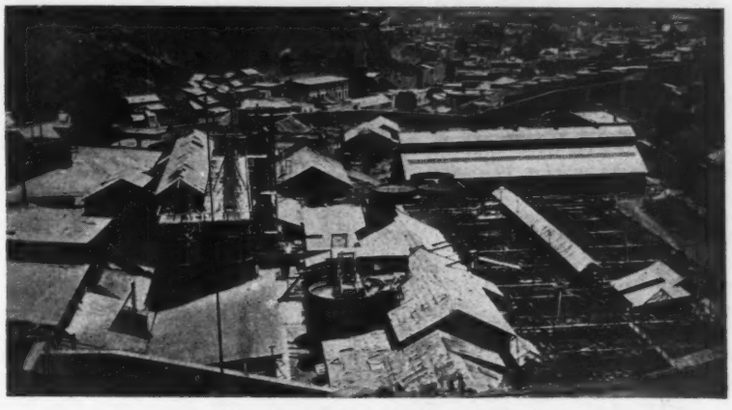
Phelps Dodge is remodeling one section of its Copper Queen concentrator, at Bisbee, Ariz., to test the possibilities of increasing capacity without building a new addition. Page 562.

* * *

Noranda Mines will deepen the Nos. 3 and 4 shafts to 1,500 ft. at the Horne mine, in northern Quebec. No details announced yet for financing of the new refinery. Page 562.

* * *

Magma Copper will sink a new shaft, to be known as No. 7, west of its concentrator at Superior, Ariz. This new unit will be used for ventilation only and will be 2,800 ft. deep. Page 562.



The Loreto plant of Real del Monte

Real del Monte Enlarging Loreto Mill and Driving Haulage Tunnel at Pachuca

Company Completes Cyanide Regeneration Plant in New Operating Program—All Ore Will Be Hoisted and Milled Together —Tramway and Guerrero Plant Will Be Closed

ENLARGING the Loreto mill so as to handle the entire output of silver ore from its properties at Pachuca, State of Hidalgo, Mexico, and driving a new 5,500-m. haulage tunnel, which will supplant the cable tramway that has long been in operation at Pachuca, are the chief features of the new operating program of Real del Monte y Pachuca, Mexican subsidiary of U. S. Smelting, Refining & Mining. This work is scheduled to be completed by March 1, 1930, and the present progress indicates that the schedule will be maintained.

Real del Monte mills about 3,500 metric tons of silver ore daily. This ore comes from mines in the Pachuca, Real del Monte, and the El Chico districts, on the south, north, and west slopes, respectively, of the Sierra de Pachuca. Pachuca is the railroad terminal, and the main shops, warehouses, and offices of the company are situated there. Mack trucks handle the freight from the railroad to the mines and mills of the different districts.

For many years the company has operated two mills. The Loreto mill, with a capacity of 2,400 metric tons daily, is in the town of Pachuca, and the Guerrero mill, with a capacity of 1,100 metric tons daily, is about 2 km. below Real del Monte. Both mills handle ore from more than one mine, and most of the ore is now delivered over cable tramways.

Last March the company decided to centralize all milling at the Loreto mill, in Pachuca. When the construction now under way is finished, the Loreto mill will handle the entire tonnage of 3,500 metric tons, and the Guerrero mill will be shut down. In the past, primary grinding at Loreto was done by 70 1,450-lb. stamps and two No. 86 Marcy mills in open circuit. Secondary grinding was by rock mills of various sizes, in closed circuit with Callow screens and Dorr classifiers. After thickening and agitation, the pulp was filtered with Butters filters.

Under the new arrangement, the run-of-mine ore will pass to a 20-in. Traylor gyratory, then to grizzlies and screens, with the oversize going to two 5½-ft. Symons cone crushers. A ⅝-in. product is expected from the crushing plant. The primary grinding equipment will consist of three No. 86 Marcy mills, now in service, and four new 6x12-ft. Traylor rod mills, all in closed circuit with 6-ft. Dorr classifiers. Secondary grinding equipment will consist of eight new 6x10-ft. Traylor ball mills in circuit with 8-ft. Dorr classifiers, and eight 5x10-ft. ball mills with 6-ft. Dorr classifiers. The latter mills have been made from 5x16-ft. and 5x20-ft. rock mills heretofore used. The thickener, agitator, and filter capacities are being increased. A cyanide regeneration plant of sufficient size to cope with the in-

One of the Real del Monte mines in the Pachuca district

creased scale of milling has just been completed.

To bring all the ore to the Loreto mill, important changes in ore handling were necessary. The San Juan Pachuca shaft, which is only a few meters from the ore bins at the Loreto mill, is being equipped to hoist all the ore for the mill, except the ore from the El Chico district, which will still be delivered over the tramway connecting El Chico and Loreto.

Last February, drifting was commenced in the east face of the 270-m. level of the San Juan Pachuca mine and in the west face of the 550-m. level of the La Rica mine in Real del Monte. The 270-m. level of the San Juan Pachuca mine is about 30 m. below the 550-m. level of the La Rica mine. When these two drifts connect, the haulage level will be about 5,500 m. long, with a uniform cross-section of $8\frac{1}{2}$x9 ft., and with grades from $\frac{1}{2}$ to $\frac{3}{4}$ per cent in favor of the loads. About 1,500 m. of the old 270-m. level of San Juan Pachuca was enlarged and that level now forms a part of the haulage level. However, 4,000 m. of new drifting was required, of which 3,600 m. has been done, and 400 m. remained to be done on Sept. 20. This connection will be made about Nov. 1 if the present rate of drifting is maintained.

All the mines of the Real del Monte district have in common the 400-m. haulage level. Ore gathered on this level will be hauled by electric motors to large storage pockets at the La Rica mine. These pockets extend from the 400-m. level to the drawing gates on the new haulage level (550-m. level La Rica). On that level, the ore will be hauled to the pockets at the San Juan Pachuca shaft. For this haulage, a train of seventeen 12-ton cars and two 13-ton locomotives will be used.

Underground transportation and central hoisting will reduce hoisting and ore-handling charges and also reduce the theft of ore, which is common on all cable tramways. Combined milling will result in reduced freight charges, reduced overhead, and better supervision, and will make possible one central cyanide recovery plant. New and better machinery is also expected to reduce the unit milling costs of the company considerably.

Start Work on New Sudbury Sulphuric Acid Plant

WORK has been started on the new plant Canadian Industries is building in the Sudbury district of Ontario for the manufacture of sulphuric acid and niter cake from the fumes of the new International Nickel smelter. Fraser Brace Engineering, general contractors for Ontario Refining and International Nickel in the construction of new plants at Copper Cliff, has been awarded the contract for this work also.

Plant and equipment will cost about $1,500,000, according to an announcement from company headquarters in Montreal. When in operation, the plant will handle about 200 tons daily and will employ about 30 men. The bulk of the sulphuric acid produced at first will be used to treat sodium sulphate from Saskatchewan in the manufacture of niter cake, which Canadian Industries is under contract to supply International Nickel. From time to time, as new chemical developments based on smelter fumes prove commercially feasible, plant extensions may be made. Canadian Industries, which took over the Mond sulphuric acid plant at Coniston, is now engaged in experimental work with this end in view.

Drills Strike New Orebody at Depth in Pecos Mine

DRILLING south of the main operating shaft at the Pecos mine of the American Metal Company of New Mexico, near Santa Fe, N. M., has disclosed the presence of a new lens of complex lead-zinc ore. Drills operating from the surface and from the 800 level have proved the deposit to extend from the 800 level, at present the deepest working in the mine, to the equivalent of the 1,100 level. The three-compartment main shaft will be deepened from 800 ft. to 1,100 ft. to permit development work.

This discovery proves the existence of at least three lenses of ore on the Pecos property, which was taken over by American Metal in 1925 and which has been in production since 1927. At the time it was acquired, two orebodies, developed through two shafts, were known—the Evangeline and the Katydid. These were contained in a shear zone, made up of several parallel bands, striking N. 45 deg. E. A new shaft was sunk south of the Katydid orebody, and all operations have since been conducted through it. The new orebody is southeast of this shaft, but is also within the shear zone, which has a total width of 1,000 ft. in this area. Drilling operations will be continued south of the new orebody and north of the Evangeline orebody, where the zone turns almost at right angles.

Operations of the Pecos mine and mill are being continued on a profitable basis. About half of the bonds issued to finance equipment of the property have been retired, and the accumulated interest on the remainder has been paid. No increase in production will follow the development of the new orebody, however. At present about 600 tons are mined and milled daily.

New Pump Ordered for Ahumada's No. 8 Level

A NEW Allis-Chalmers pump, with a capacity of 500 g.p.m., is being installed at the Ahumada Lead property, at Los Lamentos, Chihuahua, Mexico. This pump will supplement the present pumping equipment, which has a capacity of about 2,400 g.p.m., pumped to the surface. Development work on the No. 8 level of the mine has encountered a large flow of water. With the new equipment, it is expected that this water can be well taken care of.

Production from the No. 8 level of the mine has been limited to date because of the water conditions there. Most of the output is coming from Nos. 2, 4, 5 and 7 levels. In the first half of September the tonnage shipped was slightly higher than the average shipments for like periods in July and August. Production for the year is being maintained at about the same rate as in 1928—12,000,000 lb. of lead annually.

Erupcion Mining, which is controlled by Ahumada, surrendered its option on the Mosqueteros property, near Cerros Colorados, Chihuahua, late in August. Production in small quantities is being continued from the company's mine at Los Lamentos, but exploratory work is being carried on with hopes of increasing the ore reserves.

Fire Destroys Surface Plant at Terrible Edith

Destruction of the surface plant at the Terrible Edith mine, at Murray, Idaho, resulted from a fire at the property on Sept. 19. Damage done is estimated at $30,000. Three men who were trapped in the mine workings by the fire were rescued alive by a party from the Hecla mine several hours after the fire started. They had erected a barricade 1,000 ft. from the portal of the main tunnel to protect themselves against the smoke.

U. S. Steel Building Zinc Mill at Jefferson City

CONSTRUCTION of an 800-ton flotation plant to treat zinc ore from the mines of Universal Exploration, a subsidiary of U. S. Steel, has been started at Jefferson City, Tenn., 14 miles northeast of the Mascot district. Operation of the plant will probably start early in 1930.

The plant will have a crushing capacity of 2,400 tons daily, and the flotation department is being designed so as to permit raising it to the same capacity with a minimum of effort and expense. Crushing will be done in gyratory crushers and 4-ft. Symons cone crushers. The ore will then be stored in ore bins, whence it will be sent to rod mills and to two Minerals Separation flotation machines.

Ore at Jefferson City is sphalerite. American Zinc, Lead & Smelting is operating in this district also, and 6 miles away Grasselli Chemical has developed a sulphide orebody at New Market.

Burma Corporation Reports New Development Results

DEVELOPMENT WORK on both the Shan Lode and Chinaman orebodies of Burma Corporation at its Bawdwin mine, in Burma, is progressing favorably, according to recent reports from the company. Crosscutting on the No. 9 level in the Chinaman area at a point 1,589 ft. south of the shaft has cut ore in two sections, one 11 ft. wide and the other 16 ft. wide. The first section assayed 26.4 per cent lead, 4.1 per cent zinc, and 8.3 oz. of silver per ton, compared with 18.5 per cent lead, 4.1 per cent zinc, and 10.3 oz. of silver in the second. Crosscutting on the No. 10 level of the Shan lode has struck ore both east and west of the level. In the east crosscut four oreshoots, varying from 2½ to 15½ ft. in width, were encountered within 100 ft. of the main drift. Lead content averaged about 16 per cent, with about the same amount of zinc and from 8 to 19 oz. of silver per ton. In the west crosscut only one oreshoot, 6 ft. wide, has been struck. It assayed 17.4 per cent lead, 32 per cent zinc, and 21 oz. of silver per ton.

B.&B. Quick Installing New Rotary Furnace

Installation of a new Gould rotary furnace, 4x60 ft., is now under way at the B.&B. Quicksilver property, Esmeralda County, Nev. It will have a capacity of 80 tons daily. Other new equipment, including an 80-hp. Fairbanks-Morse Diesel engine, with a 65-kva. generator, and a new Sullivan angle compound air compressor, is being installed. Production from the old furnace, with a capacity of 60 tons daily, was about 175 flasks a month. E. J. Bumsted, recently appointed superintendent, will supervise construction of the plant. Richard F. Brown, engineer of H. W. Gould & Company, will join Mr. Bumsted at the property to work out the details of the installation.

New 800-Hp. Hoist Ordered for Kennedy Mine

INSTALLATION of a new 800-hp. Allis-Chalmers hoist, which will replace the temporary hoist now in operation at Kennedy Mining & Milling, near Jackson, Calif., will start about March 1, 1930. The Kennedy shaft is 4,764 ft. deep, including the sump, and has three compartments, two for hoisting and one for the manway and the pipeway. Work has already started on exploration of the Kennedy vein at even greater depths through an auxiliary incline shaft, sunk in the footwall about 200 ft. from the vein.

The new unit, which will be installed at the surface, will be a single-gear-reduction, motor-operated two-drum hoist. Drums will be 8 ft. in diameter, with a 6-ft. face, providing for 4,900 ft. of 1¼-in. rope in four wraps. Each drum will be provided with parallel motion post brakes and with Allis-Chalmers double-disk, multiple-arm friction clutches, the clutch drum being of cast steel. Oil under pressure for post brakes and clutches will be supplied by an accumulator and pump. The maximum diameter of the drum shaft is 14 in. The pinion shaft has a diameter of 7½ in. Indicator dials are 5 ft. in diameter and Lilly safety controllers are provided.

Maximum rope speed will be 1,500 ft. per minute. The motor will be of the wound rotor type. Maximum load when hoisting ore is: skip, 5,300 lb.; ore, 9,600 lb.; weight of 1¼-in. rope, 4,900 ft., 12,000 lb.; and maximum rope pull, 26,900 lb. Less the weight of the descending skip, 5,300 lb., this leaves an unbalanced load for motor of 21,600 lb.

Report Gold Discovery in Solomon Islands

A gold discovery has been reported in the Solomon Islands, a group in the south Pacific. The gold occurs, according to report, in both lode and alluvial deposits, and is about 20 miles inland on the island of New Georgia. Large numbers of plantation owners and traders are reported to have taken out miners' and prospectors' licenses. The islands belong to Great Britain.

St. Anthony Gold Ships First Brick

Shipment of the first gold brick from the test mill of St. Anthony Gold, operating in the Sturgeon Lake district of northwestern Ontario, has been made. The brick had a value of $2,800. Mill heads averaged $11.70 a ton. This property has been opened to 500 ft., and officials claim that ore reserves are sufficient to insure two years of operation by the amalgamation mill.

Aramayo Mines Driving New Drainage Tunnel

COMPLETION of the new drainage tunnel, which Aramayo Mines is driving at its Chorolque property, in Bolivia, is expected at the end of this year. The new tunnel, which will be 950 m. long, was started last November. According to the most recent report it has already been driven more than halfway. It was started from the southwest side of Chorolque Mountain and will cut a winze 130 m. below the San Bartolome tunnel. These workings were flooded in November, 1926. The cost of pumping the volume of water which has developed became excessive, and the water level could only be kept below 75 m. with the equipment on hand.

Use will be made of the water flowing from the new tunnel by diverting it to a large alluvial tin deposit on the south side of the mountain. The potential value of this deposit has long been known, but no water has been available for its exploitation.

Production from the Chocaya unit of the company has been slightly curtailed as the result of remodeling of the concentrator. New machinery is being installed to raise the percentage of metals recovered. During the first half of the year, output was at the rate of 3,800 tons of concentrate annually, as compared with 4,200 tons produced last year.

25 Papers Being Prepared in Milling Methods Study

A COMPREHENSIVE outline has been prepared by the mining division of the U. S. Bureau of Mines as a guide to mill superintendents for the preparation of papers on their milling practice. C. W. Wright, chief of the mining division, who has just returned from an extended trip throughout the West, says that the idea of getting the mill men in each district to describe their milling methods and give detailed supply consumption and cost data has been most favorably accepted by the officials of the mining companies. Already, 25 mill superintendents have accepted appointments as consulting engineers to the bureau and are preparing the papers on their milling operations.

This new undertaking of the Bureau of Mines, following as it does the mining methods study, will be a further aid to the industry by the dissemination of up-to-date data on modern milling practice. These papers will contain detailed data on ore crushing, grinding, flotation, and other problems.

New Ore at Central Eureka

Central Eureka, at Sutter Creek, Calif., reports striking a new orebody on its 4,700 level. Station and bin construction has been completed on the 4,850 level. The main shaft of the Old Eureka property is being unwatered below the 2,200 level. Ore has been encountered on the 2,100 level.

Construction Now Paramount at Flin Flon and Sherritt-Gordon

With Large Ore Reserves Assured, Northern Manitoba Companies Can Devote Attention Largely to Building Programs— Important Copper and Zinc Output Envisaged

G. C. BATEMAN
Secretary, Ontario Mining Association

ASIDE from the Sudbury district of Ontario, the scene of the greatest mining activity in Canada today is in northern Manitoba. Here two companies—Hudson Bay Mining & Smelting, and Sherritt-Gordon—are rapidly preparing for production, which they expect to reach by the end of 1930. The properties of these two companies are 40 miles apart and represent two different types of orebodies. The Sherritt-Gordon orebody is of the vein type, whereas the Flin Flon mine of Hudson Bay M. & S. is a large single deposit.

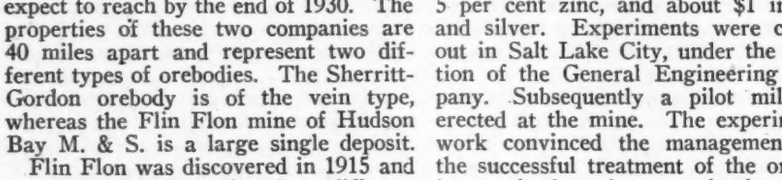
Flin Flon was discovered in 1915 and was subsequently optioned to different people at various times. It was finally purchased from the original owners by the Mining Corporation of Cobalt. After holding it for several years, this company optioned it to the Whitney interests. Since then solving of the metallurgical problems and bringing the property into production as rapidly as possible have been the chief problems.

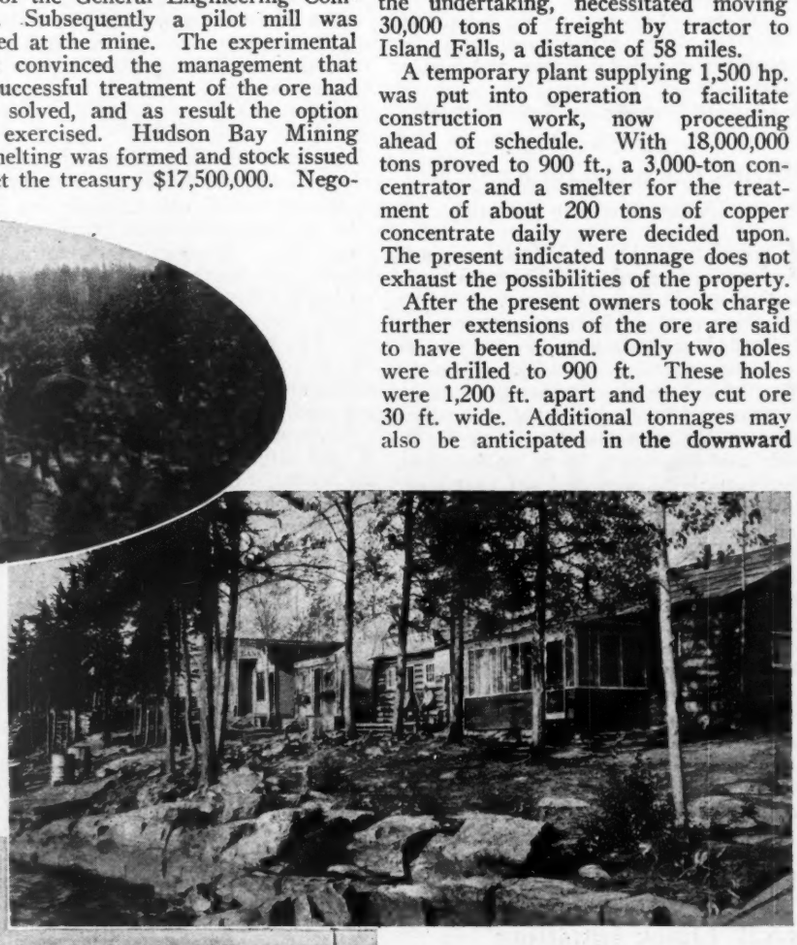
Prior to its acquisition by Mining Corporation, diamond drilling indicated 18,000,000 tons of ore of an average grade of about 2 per cent copper, 4 to 5 per cent zinc, and about $1 in gold and silver. Experiments were carried out in Salt Lake City, under the direction of the General Engineering Company. Subsequently a pilot mill was erected at the mine. The experimental work convinced the management that the successful treatment of the ore had been solved, and as result the option was exercised. Hudson Bay Mining & Smelting was formed and stock issued to net the treasury $17,500,000. Negotiations were then started for construction of a railroad spur from The Pas, an essential before any large-scale program at the mine could be started. Arrangements were finally made with the Canadian National Railroad. The line, 84 miles long, was completed toward the latter part of 1928.

A real start was then made on the building program, and arrangements were also completed for the acquisition of a power site at Island Falls, on the Churchill River. A subsidiary company, known as Churchill River Power Company, was formed to develop the site, which has a capacity of 75,000 hp., 52,000 hp. of which will be utilized. Last winter the power development alone, representing only one phase of the undertaking, necessitated moving 30,000 tons of freight by tractor to Island Falls, a distance of 58 miles.

A temporary plant supplying 1,500 hp. was put into operation to facilitate construction work, now proceeding ahead of schedule. With 18,000,000 tons proved to 900 ft., a 3,000-ton concentrator and a smelter for the treatment of about 200 tons of copper concentrate daily were decided upon. The present indicated tonnage does not exhaust the possibilities of the property.

After the present owners took charge further extensions of the ore are said to have been found. Only two holes were drilled to 900 ft. These holes were 1,200 ft. apart and they cut ore 30 ft. wide. Additional tonnages may also be anticipated in the downward





Above—The portage at Cranberry Lake, Manitoba, showing one of the many methods of traveling the modern prospector must use. At the right—The banking district of Cold Lake, center of much exploratory activity.

At the left—At Sherritt-Gordon, looking northwest toward the bunkhouse. The old camp buildings are at the right. This is one of Manitoba's biggest mining enterprises.

extension. A new main shaft, equipped with steel sets and having five compartments, is now being sunk.

In addition to the mill and smelter and the necessary mine buildings, a model town is being built and provision is being made for a partial draining of Flin Flon lake. The ore deposit has a length of approximately 3,000 ft. and an average width of 70 ft., with the greatest width in the upper portion of the body. The first 300 ft. will be mined by steam shovel. A horse of rock in the upper portion of the body will dilute the average grade to about 1.75 per cent copper, 3.5 per cent zinc, and 75c. in gold and silver.

Estimated production is 30,000,000 lb. of copper and 50,000,000 lb. of zinc annually, and estimated profits are $3.50 per ton based on 15c. copper and 6c. zinc. Hudson Bay copper will probably be refined in the new Noranda refinery. At present about 2,000 men are employed.

The Sherritt-Gordon orebody was discovered several years after the Flin Flon, but should be in production at about the same time—that is, by the end of 1930. A large amount of diamond drilling and some underground work indicated sufficient ore to justify the company in guaranteeing the construction of a railroad, which was completed in August, five months ahead of schedule.

Sherritt-Gordon has 6,000,000 shares, of which 1,000,000 shares are in the treasury. In addition to cash on hand, $1,500,000 has been deposited as a guarantee for the construction of a 1,500-ton concentrator, which was necessary to assure the railroad. As soon as $500,000 has been spent on this plant, that amount will be returned out of the deposit and the balance can be drawn as needed, so that financing does not offer any problem.

The company owns about 5 miles along the ore zone. To date two bodies, separated by a barren zone 2,000 ft. long, have been developed. The east orebody has a length of 4,500 ft. and the west body, 6,500 ft., with average widths of 15 ft. Diamond drilling has been carried to a maximum depth of 1,000 ft. Two prospecting shafts, 7,000 ft. apart, have been sunk to 375 ft. and development work has been done on three different levels. To the present, 55,000 ft. of diamond drilling has been done. On the three levels of the prospecting shafts 9,250 ft. of drifting and 5,150 ft. of crosscutting have been accomplished. This work indicates ore having an average grade of 3 per cent copper, 3 per cent zinc, and $1 in gold and silver.

At present a new main shaft is being sunk. This shaft, which has five compartments, is being sunk at the extreme west end of the deposit, 4,000 ft. west of the No. 1 shaft. It is at an incline of 47 deg. The present objective is 1,500 ft. on the incline, giving a vertical depth of 1,000 ft. It has now been put down 400 ft.

A geological survey of the property made in the summer of 1929 has shown that the Sherritt vein occurs in a fold of the sediments, which it crosses at an angle. The barren zone, 2,000 ft. long, is believed to have definite ore-carrying possibilities on the under side of the fold.

A 1,500-ton flotation concentrator is being erected. Part of the work in connection with this plant was done by the Southwestern Engineering Company, but most of it was done by Sherritt-Gordon's own engineers.

Arrangements have been completed for the treatment of copper concentrate at the Hudson Bay smelter. The blister copper will be returned to the Sherritt-Gordon company and will be shipped to the refinery now being erected at Sudbury. No announcement has been made regarding the disposition of zinc concentrate, which will probably be treated in the plant to be built in Eastern Canada by Consolidated Mining & Smelting and Ventures.

Arrangements have also been made for power supply from the Churchill River Power Company. Construction of the power line will be started this winter. At present a 360-hp. Diesel engine is in operation. This power is used chiefly for the 15-ton test plant and for the sinking of the new shaft. As at Flin Flon, everything is being subordinated to the construction program. Work on the property is ahead of schedule, and about 400 men are employed.

Estimated output of the concentrator is 27,000,000 lb. of copper a year, in addition to zinc and precious metals. The concentrator now being built will probably be the first unit of a larger plant to be constructed subsequently. With Sherritt-Gordon, as with Flin Flon, ore reserves are not a problem. A length of 11,000 ft. and a width of 15 ft. would indicate 15,000 tons per foot of depth. Underground development has been carried to 375 ft. and diamond drilling to a maximum of 1,000 ft. The reader can make his own estimates. These figures indicate that another 1,500-ton unit will probably not be long delayed.

Other properties of lesser importance are found throughout the district. Chief interest and the greatest amount of work, however, are centered in Hudson Bay and Sherritt-Gordon. The Mandy mine, in which Tonopah Mining holds a substantial interest, is in the same neighborhood. This mine was worked during the war, and high-grade copper ore was shipped to Trail. About 100,000 tons of low-grade ore was left in the mine. During the last two years a large amount of work has been done in an effort to locate other orebodies. The main shaft was sunk to 1,000 ft., and exploration has been carried on at 625, 825 and 1,000 ft. So far results of this work have been disappointing. Diamond drilling is now being done below the 1,000 level, but no results of this work are available.

The two plants now under construction indicate a production of 57,000,000 lb. of copper and 75,000,000 lb. of zinc a year. Another mill unit at Sherritt-Gordon would increase the output of the district to 85,000,000 lb. of copper and 110,000,000 lb. of zinc a year.

Considering the difficulties under which these companies started operations, remarkable progress has been made. These ventures represented real pioneer efforts, as the ore deposits were in an entirely unsettled country, with no transportation, no power, and no settlement within almost 100 miles. Their success will mean much to Manitoba, which has up to now been considered almost entirely as an agricultural province. The Hudson Bay smelter will be the first to be built in the vast territory between Ontario and British Columbia.

Seven Troughs Finds Third Vein in Tunnel

At about 8,250 ft. from the portal, the tunnel being driven by Seven Troughs Gold, near Lovelock, Nev., entered the vein worked in the old Coalition workings. This is the third vein struck in driving the tunnel. Drifting on the first vein, hit 5,100 ft. from the portal, has been continued for 600 ft. in mill-grade ore. About 100 ft. of ore has been drifted on the second vein, struck 5,400 ft. from the portal. No exploration work has yet been done on the third vein, according to L. A. Friedman, president of the company. Cement for the foundation of the first unit of the mill is now being poured.

Power Company Buys Dunwell Mining Plant

Purchase of the power plant of Dunwell Mining, in the Portland Canal district of British Columbia, has been announced by the Power Corporation of Canada, Ltd. The plant consists of a 300-hp. Vickers-Petter Diesel engine, a 450-kva. generator, and transformers. Power will be supplied the town of Stewart from this plant until the American Creek hydro-electric plant is completed next year. Terms of the contract provide that the mining company be supplied with power at a rate which is about half the cost at which it had been producing its own power. Dunwell owns a 200-ton mill, now inactive.

Jefferson Lake No. 2 Well Fails to Hit Sulphur

Jefferson Lake Oil's No. 2 well at Lake Peigneur, La., struck caprock at about 550 ft. and was drilled through limestone and gypsum to the underlying rock salt at 866 ft. without finding any sulphur. This well is 800 ft. northwest of No. 1 well, completed in March, on what was thought to be the edge of the Jefferson Island salt dome. It was drilling for oil, but struck caprock showing some sulphur. A third well is now being drilled about 250 ft. from the first well to determine whether the sulphur showing extends even that distance.

Phelps Dodge Testing Capacity of Bisbee Mill

AT THE Copper Queen concentrator of the Phelps Dodge Corporation, Bisbee, Ariz., one unit is being used for an intensive test of classifier capacity. The primary mills in this section will be put in closed circuit with the classifiers to ascertain what improvement can be obtained by closed circuit classification. Also, the two 6x12-ft. Marcy mills in this section will be replaced with 8½x12-ft. units, with 16x23⅓-ft. Dorr classifiers. If these tests are successful, a material increase in mill capacity should result, with no changes to the building.

A new 2,250-hp. Nordberg Diesel engine, with two new 2,000-kva. generators, has been ordered for the Copper Queen Diesel plant. Installation is expected to be completed early next year. About 1,800 kw. will be added to the plant capacity.

Construction of the anode plant at the Douglas smelter is about half completed. This plant will probably be put in operation by Dec. 1. Practically all the plans for the new crushing, screening, sampling, and bedding plant have been completed and contracts have been let for the excavation and steel erection. Concrete and foundation work will be done by the company. In addition, the calcine bins above the reverberatory furnaces will be replaced with a new bin system, developed by the Copper Queen staff. Installation of this bin should result in a material improvement from both an operating and metallurgical standpoint. The reverberatory furnaces will also be equipped with the new Queen reverberatory-type oil burners, which have been developed at the plant.

Old Dominion Completes 300-Ton Mill Increase

OLD DOMINION has recently added two new 8-ft. Dorr classifiers to its concentrator at Globe, Ariz. One classifier has been placed in closed circuit with a 6x12-ft. Marcy rod mill, and the other has replaced a 4½-ft. Dorr classifier in the regrinding section. The two new classifiers have increased the capacity of the concentrator about 300 tons daily, to a total capacity of 1,600 tons. The increase in the capacity of the concentrator is to make possible the treatment of a larger amount of low-grade ore so as to maintain production of copper, as very little higher-grade ore has been developed recently.

At present the daily tonnage treated is about 1,500 tons, because two Hardinge ball mills are down for repairs. Fine grinding at Old Dominion is done in Hardinge mills in closed circuits with Dorr classifiers. Before entering the Hardinge mills, ore from the crushing plant is ground in rod mills, one of which is the Marcy above mentioned and the other a 4x8-ft. Marathon. The Marcy mill was installed several years ago and was the means of increasing the mill capacity from 1,000 to 1,300 tons per day.

About 175 tons of concentrate and 50 tons of shipping ore are sent to the International smelter at Inspiration daily. D. L. Forrester is mill superintendent at Old Dominion and R. S. Allen is metallurgist.

Rainfall Averts Power Shortage in Chihuahua

COPIOUS rainfalls in the mountains of central and eastern Chihuahua, Mexico, during the last few days have removed the threat which has been hanging over the heads of mining companies operating in that state, of having to reduce the scale of operation because of shortage of power. In fact, Electric Bond & Share, operating the power plant at the Boquillas dam, near Santa Rosalia, Chihuahua, recently informed users of its power that they would have to curtail their demands by about 25 per cent. Development work in the mining districts was threatened and the possibility also existed of having to make a large cut in production. However, according to Mexico City dispatches dated Sept. 30, the big dam is filling rapidly and a normal supply will soon be available.

Work on a new 16,000-hp. plant at Torreon, Coahuila, is being rushed by Electric Bond & Share. It will probably be completed in February and will be used to supplement the Boquillas supply. As this plant will generate electricity by steam power, rather than hydro-electrically, the possibility of the recurrence of a shortage is considerably diminished.

Silver Reef Unwatered to 500 Level Now

Unwatering of the old California shaft at the Silver Reef mine, Washington County, Utah, has now been carried below the 500 level and mapping of the stopes has been completed by the Western mining department of American Smelting & Refining, which holds the property under option. On the 460 level of the new three-compartment shaft a 16-ft. drill hole has drained the Savage mine stope.

Spokane Men Buy Goldstone

Andrew Prader and his associates, of Spokane, Wash., have bought the Goldstone mine, on Pratt Creek, near Salmon, Idaho. A hydro-electric plant is being built on the creek, 4 miles from the mine. Improvements are being made on the roads to permit shipments of concentrate from a small flotation plant, recently built at the property. The ore carries gold, lead, and silver.

Magma Copper to Sink New 2,800-Ft. Shaft.

MAGMA COPPER has announced plans for sinking a new three-compartment shaft to a depth of 2,800 ft. at its property near Superior, Ariz. The new shaft will be known as No. 7 and will be sunk 700 ft. due west of the concentrator and 8,000 ft. west of No. 6 shaft, which will be near the Miami-Superior highway. The tunnel to No. 6 shaft is finished and is being lined with concrete. When this is done the shaft will be raised to surface, a distance of 250 ft. Then it will be sunk to 2,250 ft. Both No. 6 and No. 7 shafts are being sunk mainly for ventilation purposes.

The work of concreting No. 4 shaft from the surface to the 1,550 level was completed on Sept. 15. This is the main upcast ventilating shaft of the mine at present. After No. 2 shaft is concreted from the 2,600 to the 2,090 level, it will be sunk to the 3,250 level.

The shaft work program will cover a period of three years and will cost about $2,000,000, of which $500,000 will be for sinking No. 7 shaft. Magma will then have six shafts in use, of which Nos. 2, 3 and 5 will be downcast and Nos. 4, 6 and 7 will be upcast.

Noranda to Deepen Main Shafts to 1,500 Ft.

DEEPENING of No. 3 and No. 4 shafts, the main operating units of the Horne mine, is included in the development program of Noranda Mines, operating in the Rouyn district of Quebec, according to J. Y. Murdoch, president of the company. He stated that a large tonnage of good-grade ore has been proved below the 1,000 level of the mine, at present the deepest workings, and that the two shafts will be continued to 1,500 ft.

Securing of a contract for refining Flin Flon copper by Canadian Copper Refineries, the Noranda subsidiary formed to build a copper refinery in eastern Canada, has necessitated a revision of the construction plans. Until the size and cost of the refinery have been determined, no announcement can be made regarding financing for the plant.

Newbec Drill Cuts New Ore

Newbec Mines has cut 15 ft. of medium-grade copper ore at a depth of 300 ft. at its property in the Rouyn district of Quebec. This is the first result reported from the campaign of diamond drilling recently started to explore a contact zone, about 1,000 ft. long, between the Newbec and Gold Pan outcrops. These two properties were consolidated on the strength of these showings. Two diamond drills are now in operation, one from the surface doing exploration work and the other at 125 ft., checking results of underground work at that level.

MARKET AND FINANCIAL NEWS

American Smelting Net for Half Year $10,947,501

THE American Smelting & Refining Company reports a net income for the six months ended June 30, 1929, of $10,947,501 after interest, taxes, depreciation, and other charges, which compares with $8,219,451 in the first half of 1928. The profit for the half year equals $5.02 a share earned on the 1,829,940 shares of common stock which will be outstanding when all of the $100 par stock has been exchanged for no-par shares. Total current and miscellaneous assets of the company amount to $99,301,470, more than 3.83 times the total current and miscellaneous liabilities, the latter figure being placed at $25,884,037.

Simon Guggenheim, president, commenting on the position of the company, said:

"At the end of the first half of 1929, the American Smelting & Refining Company had on hand in cash, in demand and time loans and U. S. government securities $26,668,743, a decrease of $553,742 from the total of the same items on Dec. 31, 1928. Cash on hand would have been materially larger had it not been for the revolution in Mexico last spring. The company's mines and smelters were operated during military activities, but it was not possible to ship bullion out of Mexico, and thus the cash realization of metal values was greatly delayed. All operations have now become normal, and by the end of the year excess metal stocks thus caused are expected to be largely if not entirely liquidated."

Value of Canadian Mineral Output at Record Level

MINERAL production of Canada for the first half of 1929 shows a total of $123,702,334, a gain of over 17 per cent, compared with the corresponding period of 1928, according to the Dominion Bureau of Statistics. Metals as a group showed the greatest gain, with a value of $75,476,321, an increase of 20 per cent over the corresponding period of 1928.

Greater outputs are reported for all metals except arsenic, cobalt, lead and metals of the platinum group, but in the case of cobalt and lead, though the output was less, the total value was higher. Silver production showed an increase, but lower prices resulted in a slightly lower money value. The principal minerals in the value of production were copper, gold, and nickel, followed by lead, silver, and zinc. Production of copper was 116,500,000 lb. valued at $21,125,000, an increase of 24 per cent.

Gold production was valued at $19,432,000, an increase of 3.7 per cent. Of the total Ontario contributed $16,500,000, or 85 per cent of the total ouput, and of this sum Porcupine contributed 56 per cent. The increase in gold is largest in Quebec, where the output for the half year, $799,000, was considerably greater than that for the full year of 1928. Practically all of this came from blister copper of the Noranda mine.

The production of nickel was 55,000,000 lb., valued at $12,872,000, an increase of 18.3 per cent in quantity and 21 per cent in value. Lead production amounted to 156,110,000 lb., valued at $8,116,000. Silver production was 11,307,000 oz., valued at $6,253,000, an increase of 4.7 per cent in quantity but a decrease of 1 per cent in value. Zinc production increased 10,000,000 lb., to a total of 103,330,000 lb., valued at $5,956,000. The record shows that 1928 was the record year in Canadian mineral production, but the figures for the first six months of 1929 indicate that another new record will be established this year.

BURMA CORPORATION, LTD., India, mined 39,289 tons of ore in August, including 3,680 tons of high-grade ore. The treatment plant milled 30,000 tons of ore, producing 10,365 tons of lead concentrates. The blast furnaces smelted 11,712 tons of lead-bearing material, producing 6,208 tons of hard lead for treatment in the refinery. Refinery output in August consisted of 6,505 tons of lead and 600,194 oz. of silver.

Belief That Rhodesian Shares Are Too High Noted in London

W. A. DOMAN
Special London Correspondent

LONDON, Sept. 17, 1929—During the last few days, interest in Rhodesian copper shares has been less keen, possibly because certain cautious persons are beginning to think that prices have advanced a little too rapidly. No one doubts the richness of the deposits, but the question is asked: What dividends can be paid, and when will they be paid, to warrant the existing market capitalization? The answer, of course, is that dividends cannot be paid for some years. At present prices, companies could issue new shares at substantial premiums, and so raise now a large part of the great amounts of working capital that will be required before the production stage is reached. Prices are years ahead of realities, and engineers and private communications speak rather hesitatingly of the labor problem. One well-known man goes so far as to assert that the labor is not available. To operate the great deposits profitably, large-scale production is essential, and even Bwana M'Kubwa cannot yet earn a profit. In some quarters the belief is that, as Union Minière employs large quantities of labor and will never lack supplies [other reports indicate U.M.K. has had trouble getting men—EDITOR], the Northern Rhodesian companies not so far away will have the same good fortune. But one of my informants reminds me that Union Minière is producing largely from opencast mines. To recover the copper in the Rhodesian mines, shafts must be sunk. The Central African native is not keen on going underground, because he discovers that life is shortened thereby. I am not writing as a pessimist, but simply recording the opinions of engineers and others who claim to know. This can be said in favor of the Northern Rhodesian properties: they will be equipped with the latest mechanical devices, and with the powerful associations behind them they can raise all the capital that will be required. As one engineer says, the problem is labor, and again labor, and yet again, labor.

A good deal is heard of manganese at the moment, and companies in both India and Africa are getting busy. The Harrimans are reported to have been "done" in Russia, and have accepted Russian bonds in exchange for their properties. The Soviet is reported to be trying to undersell all other producers. Even the Central Provinces Manganese Company (India) has felt this influence, and has had none too good a time. It has appealed to the railroad administration in India for a reduction in rates to meet the competition, and is hopeful of getting from that body a prompt decision in its favor.

In South Africa, South African Manganese, Ltd., has approved a provisional agreement granting to Becker's Trust Company the exclusive right for six months to prospect the company's farms in the Postmasburg district, with the exclusive right to acquire the farms. A new company, called the Managnese Fields, Ltd., has been registered at Pretoria with a capital of £100,000 to take over two smaller corporations, each with a capital of £40,000.

World Copper Production Down in August

THE world's production of copper in August was 173,729 short tons, which compares with 174,347 tons in July and 196,820 tons in April, the peak month for the current year, according to the American Bureau of Metal Statistics. August production in 1928 amounted to 161,838 tons.

Output of reporting countries, in short tons, during August, July, and April, the latter month being the peak for the current year, follows:

	(a) April	July	August
United States	110,313	94,690	91,735
Mexico	5,584	5,627	5,018
Canada	5,878	7,490	7,770
Chile and Peru	39,195	31,222	30,971
Japan	6,835	6,954	7,166
Australia	318	757	1,421
Europe (a)	12,800	11,600	13,200
Belgian Congo	12,897	13,007	13,448
Elsewhere (b)	3,000	3,000	3,000
World's total	196,820	174,347	173,729

(a) Incomplete. (b) Estimated.

Lake Shore Dividend Raised to 30c Quarterly

AT THE annual meeting of the Lake Shore, recently held in Kirkland Lake, announcement was made that the dividend rate would be raised to 30c. a quarter, making the annual return $1.20 a share. Previous to this the regular quarterly rate has been 20c., but a bonus of 20c. has been paid for the last two years, bringing the total dividend to $1. It is probable that during the present fiscal year a bonus may be paid in addition to the dividend of 30c. for the quarter.

MONTANA IDAHO MINES CORPORATION, Helena, at a recent meeting of the stockholders, changed its name to the Montana Mines Corporation and reduced its capital from 5,000,000 shares, par value $1, to 2,000,000 shares, par value $1. Stockholders of the former company will be given one share of the last-named company for each five shares of the first-named company. Montana Mines Corporation is operating its Spring Hill mine near Helena and several properties near Winston.

ASBESTOS SHIPMENTS FROM QUEBEC mines during the first half of 1929 amounted to 134,733 tons, valued at $6,244,629, against 120,792 tons, valued at $4,892,209, in the corresponding period last year. The average price increased from $40.43 to $46.25 per ton, the gain being attributed to higher prices on the better grades.

PLATINUM AND METALS IN THE PLATINUM GROUP produced in Canada in 1928, according to revised official figures, totaled 24,139 oz., valued at $1,336,742, against a total of 22,773 oz. of these metals, worth $1,271,803, in 1927.

Tin Production in July Totaled 16,134 Metric Tons

WORLD production of tin in July totaled 16,134 metric tons, against 15,857 tons in June, and 17,097 tons in May, according to the Metallgesellschaft. The daily rate for July was 520 tons, which compares with 529 tons for the preceding month. Output for July, in metric tons, by countries, with comparative figures for June, follows:

	July	June
Malay States	6,133	5,804
Dutch East Indies	2,690	2,525
Other countries in Asia(a)	1,908	1,538
Africa	878	1,265
South Am. (Bolivia)(a)	3,900	4,100
Australia	200	200
Europe	425	425
Total	16,134	15,857

(a) Partly estimated.

Monthly average production for the first six months of the current year is placed at 15,946 tons, against 15,190 for the whole of 1928.

SILVER OUTPUT IN THE UNITED STATES in August totaled 4,967,000 oz., against 4,523,000 oz. in July and 4,776,000 oz. in August, 1928. Production of silver in all foreign countries in August is placed by the American Bureau of Metal Statistics at 8,051,000 oz., bringing the total production for the world for that month to 13,018,000 oz., against 12,391,000 oz. in August last year.

Imports and Exports of Ores and Metals in August, 1928 and 1929

Compiled from U. S. Department of Commerce Records

In Pounds, Unless Otherwise Stated

Imports

	August 1928	August 1929
Antimony		
Ore — Gross weight	326,700	.....
Ore — Antimony content	153,200	.....
Copper		
Ores, copper content	9,869,461	15,382,017
Concentrates, copper content	1,300,322	3,728,730
Regulus, coarse metal, cement copper	110,000	34,869
Imported from:		
Spain	555,144	2,332,859
Canada	4,933,487	5,010,471
Mexico	1,455,937	2,457,490
Cuba	16,108	886,944
Chile	3,857,168	4,259,529
Peru	110,483	3,812,974
Other countries	351,456	385,349
Unrefined converter copper in pigs, bars and other forms	57,493,184	89,816,692
Refined copper	5,757,648	7,666,210
Old and clippings	650,279	1,190,356
Composition metal	1,000	26,880
Brass, old, for remanufacture	884,864	1,157,587
Lead		
Ore and matte, lead content	4,265,911	11,775,733
Bullions or base bullion	19,132,884	13,158,399
Pigs and bars, old and scrap, lead content	100	52,080
Babbitt, solder, other forms, lead content	146,796	378,008
	67,592	156,237
Type metal, antimonial lead — Lead content	321,330	582,057
Type metal, antimonial lead — Gross weight	447,028	681,369
Manganese, tons		
Cuba, manganese content	104	40
Other countries, manganese content	25,996	32,943
Pyrites, tons	36,889	28,899
Tin, ore, tons	12	6
Bars, blocks, pigs	14,748,983	21,809,896
Imported from:		
Netherlands	1,737,766	2,831,465
United Kingdom	3,100,867	3,263,422
British Malaya	9,365,866	15,384,858
Hongkong	.....	247,269
Australia	185,920	33,600
Other countries	358,564	49,282
Zinc		
Ore, zinc content — Free	.....	.....
Ore, zinc content — Dutiable	208,031	124,440
Blocks, pigs, and other forms, old	.....	.....

Exports

	August 1928	August 1929
Copper		
Ores, composition, concentrates, unrefined	424,712	22,385
Refined copper in ingots and other forms	72,409,462	64,411,548
Exported to:		
Belgium	4,519,595	3,341,552
France	14,735,273	7,995,172
Germany	16,034,562	15,501,892
Italy	10,200,044	4,063,577
Netherlands	4,032,238	2,851,199
Spain	392,126	.....
Sweden	3,217,627	3,744,912
United Kingdom	16,432,458	17,913,660
Other Europe	398,684	4,895,864
Canada	976,472	2,294,094
British India	.....	.....
China, Hongkong, and Kwantung	57,800	1,165,000
Japan	1,175,790	.....
Other countries	236,793	644,626
Old and scrap	3,530,636	1,397,914
Pipes and tubes	271,786	370,832
Plates and sheets	604,051	372,296
Rods	4,699,439	6,124,519
Insulated copper wire and cables	1,705,676	1,525,046
Lead		
In pigs, bars, and other forms	.....	.....
From foreign ore	15,586,029	16,680,571
From domestic ore	3,156,318	243,628
Exported to:		
France	224,064	409,986
Germany	5,456,008	11,641,392
Netherlands	291,349	67,222
Sweden	560,432	1,187,728
United Kingdom	7,594,375	5,993,842
Other Europe	616,246	1,187,573
Brasil	240,844	.....
Other South America	71,207	224,336
China, Hongkong, and Kwantung	.....	224,223
Japan	3,647,982	5,938,661
Other countries	.....	49,236
Other lead manufactures	679,125	1,540,774
Zinc		
Ores and concentrates, tons	116	1
Dross	665,797	343,556
Cast in slabs, blocks, and pigs	5,846,121	2,796,706
Exported to:		
Belgium	.....	78,392
France	784,221	168,100
Germany	351,095	207,546
Netherlands	1,921	.....
United Kingdom	.....	1,232,463
Other Europe	191,159	.....
Japan	4,480,252	.....
Other countries	37,473	1,110,205
Sheets, strips, and other forms	654,083	1,460,292
Dust	111,817	176,617
Other zinc manufactures	140,793	68,193

Metal Statistics

Monthly Average Prices of Metals

Silver

	New York		London Spot		Sterling Exchange	
	1928	1929	1928	1929	1928	1929
January	57.135	57.019	26.313	26.257	487.098	484.577
February	57.016	56.210	26.205	25.904	487.008	484.787
March	57.245	56.346	26.329	26.000	487.558	484.776
April	57.395	55.668	26.409	25.738	487.785	484.808
May	60.298	54.125	27.654	25.084	487.685	484.599
June	60.019	52.415	27.459	24.258	487.565	484.330
July	59.215	52.510	27.262	24.289	485.923	484.560
August	58.880	52.579	27.096	24.288	484.979	484.368
September	57.536	51.042	26.440	23.708	484.654	484.253
October	58.087	.....	26.727	.....	484.584	.....
November	57.953	.....	26.704	.....	484.492	.....
December	57.335	.....	26.349	.....	484.698	.....
Year	58.176	.....	26.746	.....	486.169	.....

New York quotations, cents per ounce troy, 999 fine. London, pence per ounce, sterling silver, 925 fine.

Copper

	New York		London Spot			
	Electrolytic		Standard		Electrolytic	
	1928	1929	1928	1929	1928	1929
January	13.854	16.603	61.912	75.551	66.575	78.602
February	13.823	17.727	61.670	78.228	66.381	83.538
March	13.845	21.257	61.148	89.153	66.443	98.356
April	13.986	19.500	61.678	81.036	66.500	89.405
May	14.203	17.775	62.554	75.026	67.216	83.727
June	14.527	17.775	63.664	74.338	68.738	84.013
July	14.527	17.775	62.881	72.152	68.670	84.043
August	14.526	17.775	62.472	73.783	68.750	84.250
September	14.724	17.775	63.522	75.286	69.800	84.363
October	15.202	.....	65.524	.....	71.935	.....
November	15.778	.....	68.080	.....	74.750	.....
December	15.844	.....	69.336	.....	75.000	.....
Year	14.570	.....	63.703	.....	69.230	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

Lead

	New York		St. Louis		London			
	1928	1929	1928	1929	1928 Spot	1928 3 Mos.	1929 Spot	1929 3 Mos.
January	6.500	6.650	6.280	6.498	21.773	22.213	22.111	22.344
February	6.325	6.853	6.069	6.739	20.283	20.747	23.128	23.156
March	6.000	7.450	5.805	7.348	19.938	20.352	25.409	25.591
April	6.100	7.187	5.991	7.025	20.306	20.563	24.783	24.408
May	6.123	7.000	6.012	6.761	20.483	20.813	23.949	23.750
June	6.300	7.000	6.152	6.790	20.985	21.211	23.694	23.603
July	6.220	6.804	6.038	6.607	20.602	20.957	22.810	22.880
August	6.248	6.750	6.056	6.553	21.634	21.628	23.185	23.259
September	6.450	6.890	6.286	6.689	22.050	21.769	23.557	23.589
October	6.500	.....	6.318	.....	22.082	21.796	.....	.....
November	6.389	.....	6.222	.....	21.239	21.469	.....	.....
December	6.495	.....	6.343	.....	21.342	21.730	.....	.....
Year	6.305	.....	6.131	.....	21.060	21.271	.....	.....

New York and St. Louis quotations, cents per pound. London, pounds sterling per long ton.

Tin

	New York		London	
	1928	1929	1928	1929
	Straits		Spot	
January	55.650	49.139	253.222	222.727
February	52.440	49.347	233.833	223.138
March	52.220	48.870	232.722	220.781
April	52.270	45.858	234.204	206.887
May	51.582	43.904	230.886	197.545
June	47.938	44.240	217.280	200.206
July	47.040	46.281	212.449	209.473
August	48.012	46.619	212.847	209.815
September	48.073	45.359	215.663	204.863
October	48.966	.....	222.005	.....
November	50.750	.....	232.875	.....
December	50.185	.....	227.586	.....
Year	50.427	.....	227.131	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

Zinc

	St. Louis		London			
	1928	1929	1928 Spot	1928 3 Mos.	1929 Spot	1929 3 Mos.
January	5.643	6.350	26.125	26.051	26.196	26.233
February	5.551	6.350	25.518	25.506	26.247	26.347
March	5.624	6.463	25.082	24.960	27.050	27.294
April	5.759	6.658	25.493	25.316	26.759	26.613
May	6.026	6.618	26.102	25.756	26.727	26.619
June	6.158	6.686	25.664	25.429	26.216	25.984
July	6.201	6.766	24.946	24.972	25.332	25.418
August	6.249	6.800	24.540	24.713	24.896	25.164
September	6.250	6.799	24.497	24.625	24.208	24.688
October	6.250	.....	24.030	24.296	.....	.....
November	6.263	.....	24.801	24.827	.....	.....
December	6.349	.....	26.609	26.615	.....	.....
Year	6.027	.....	25.284	25.256	.....	.....

St. Louis quotations, cents per pound. London pounds sterling per long ton.

Antimony, Quicksilver and Platinum

	Antimony (a)		Quicksilver (b)		Platinum (c)			
					Refined		Crude	
	New York		New York		New York			
	1928	1929	1928	1929	1928	1929	1928	1929
Jan.	10.863	9.558	123.620	119.481	79.280	70.000	69.280	60.000
Feb.	10.842	9.548	121.370	119.818	84.783	70.000	74.783	60.000
March	10.083	9.531	122.557	121.904	80.000	70.000	70.000	60.000
April	9.865	9.462	123.740	122.000	80.000	70.000	70.000	60.000
May	11.019	8.957	123.173	121.154	78.000	68.615	68.000	58.615
June	9.750	8.845	122.423	120.500	78.000	68.000	68.000	58.000
July	9.540	8.543	121.260	121.654	78.000	68.000	68.000	58.000
Aug.	10.181	8.778	124.500	125.111	78.000	68.000	68.000	58.000
Sept.	10.813	8.709	128.000	124.542	78.000	66.000	68.000	56.000
Oct.	10.841	.....	125.923	.....	78.000	.....	68.000	.....
Nov.	10.109	.....	123.000	.....	76.417	.....	66.418	.....
Dec.	9.748	.....	122.500	.....	74.480	.....	64.480	.....
Year.	10.305	.....	123.506	.....	78.580	.....	68.580	.....

(a) Antimony quotations in cents per pound, for ordinary brands. (b) Quicksilver in dollars per flask of 76 lb. (c) Platinum in dollars per ounce.

Pig Iron[1] and Aluminum

	Bessemer		Basic		No. 2 Foundry		Aluminum	
	1928	1929	1928	1929	1928	1929	1928	1929
Jan.	17.50	18.00	17.00	17.50	17.25	17.50	24.300	24.300
Feb.	17.50	18.00	17.00	17.50	17.25	17.50	24.300	24.300
March	17.50	18.19	17.00	17.62	17.25	17.69	24.300	24.300
April	17.50	18.50	17.00	18.00	17.25	18.00	24.300	24.300
May	17.37	18.81	16.38	18.31	17.24	18.31	24.300	24.300
June	17.00	19.00	15.56	18.50	16.79	18.50	24.300	24.300
July	17.00	19.00	15.75	18.50	16.69	18.50	24.300	24.300
Aug.	17.00	19.00	15.75	18.50	16.50	18.50	24.300	24.300
Sept.	17.00	19.00	15.75	18.50	16.50	18.50	24.300	24.300
Oct.	17.24	.....	16.66	.....	16.74	.....	24.300	.....
Nov.	17.82	.....	17.32	.....	17.32	.....	24.300	.....
Dec.	18.00	.....	17.50	.....	17.50	.....	24.300	.....
Year.	17.37	.....	16.56	.....	17.02	.....	24.300	.....

Iron in dollars per long ton. Aluminum in cents per pound, 99 per cent grade.

[1]F.o.b. Mahoning and Shenango valley furnaces; freight to Pittsburgh, $1.76.

Monthly Crude Copper Output in Short Tons

	1928	1929					
	Total	Mar.	April	May	June	July	Aug
Domestic							
Alaska shipments	22,724	1,974	2,075	1,801	1,793	1,514	893
Calumet & Arizona	65,182	5,888	6,041	6,731	5,286	4,986	5,262
Magma	18,251	1,680	1,780	2,022	1,664	1,616	1,585
Miami	24,129	2,620	2,591	2,416	2,416	1,763	2,317
Nevada Con.	134,231	†39,191	.....	.....	†36,309	.....	.....
Old Dominion*	11,069	1,015	1,040	1,022	782	898	954
Phelps Dodge††	102,137	10,524	10,230	9,857	8,901	9,274	9,144
United Verde Extens.	22,073	2,504	2,682	2,732	2,510	2,235	2,296
Utah Copper	136,920	†40,500	.....	.....	†42,310	.....	.....
Tennessee Copper	6,792	635	619	676	638	677	659
Foreign							
Andes Copper	52,029	8,300	8,263	7,393	6,871	7,445	.....
Braden	109,137	9,375	9,265	7,630	7,630	7,620	.....
Boleo, Mexico	12,782	†2,910	.....	.....	3,637	.....	.....
Bwana M'Kubwa	6,696	686	615	317	536	561	593
Chile	132,932	16,720	16,373	14,852	12,060	11,044	.....
Furukawa, Japan	17,865	1,751	1,350	1,600	1,506	.....	.....
Granby Cons., Canada	28,767	2,452	2,631	2,591	2,518	2,467	2,510
Howe Sound	21,099	†5,157	.....	.....	.....	.....	.....
Messina	.....	.....	.....	.....	.....	667	657
Mt. Lyell	6,582	530	.....	.....	.....	600	.....
Sumitomo, Japan	17,898	1,680	1,657	1,718	.....	.....	.....
Union Miniere, Africa	123,880	11,820	12,810	13,224	12,673	13,216	13,444

†Three months. *Includes Arisona Commercial.
††Moctezuma is included.

Monthly Production of Primary Copper from U. S. Mines and Daily Rate (Short Tons)

	1927		1928		1929	
	Monthly Production	Daily Rate	Monthly Production	Daily Rate	Monthly Production	Daily Rate
January	76,198	2,458	68,469	2,209	86,325	2,785
February	69,202	2,472	67,423	2,352	84,735	3,026
March	69,314	2,236	70,327	2,269	93,698	3,023
April	71,122	2,371	69,721	2,324	94,902	3,163
May	71,613	2,310	73,729	2,378	93,392	3,013
June	69,539	2,318	73,224	2,441	82,354	2,745
July	65,545	2,114	73,426	2,369	79,229	2,556
August	67,248	2,169	76,952	2,482	78,885	2,545
September	65,936	2,198	78,341	2,611	.....	.....
October	68,545	2,225	86,480	2,790	.....	.....
November	68,080	2,269	85,382	2,846	.....	.....
December	67,377	2,173	85,677	2,764	.....	.....
Total	829,978	.....	909,051	.....	693,520	.....
Monthly average	69,165	.....	75,754	.....	86,690	.....
Average of daily rate	.....	2,274	.....	2,484	.....	2,854

The Market Report

Metals Quiet; Prices Firm Except for Tin and Silver

New York, Oct. 2, 1929—An average business has been done in lead during the last week, at unchanged prices, but zinc has been given little attention by the buying fraternity, and copper business continued below normal. Some interest in tin was aroused by the drop below 45c., and by the release of statistical data, but the market was not active. Silver, at 50c. yesterday, again touched a new low for fourteen years. The continued reaction in the stock market has, without doubt, had a chilling effect on metal business.

Copper sales improved somewhat, but producers are reverting to their former policy of turning most of the business over to the custom smelters, who have thus been enabled to book a normal amount of orders. The price is unchanged at 18c. for Connecticut deliveries and 18⅛c. in the Middle West, with over half of the business for prompt or October shipment. Export business has again been dull, at 18.30c., c.i.f., but the September total of sales, 58,250 long tons, was but little below the excellent business of the month before. Copper consumption continues active, and producers are optimistic that another good buying movement will set in at present price levels before the end of October.

Zinc has been exceedingly dull, but the full price of 6.80c. seems to have been quoted by all sellers and to have been realized on such business as was done. There seems to be a vast gulf between the producers, whose statistics show them that consumers cannot possibly postpone buying beyond tomorrow; and the consumers, who are giving the impression that they are well covered until late spring.

Lead transactions for the week made a good showing, compared with the other non-ferrous metals, sales for the period being close to the average in volume. Prices were firm but unchanged at 6.90c. in New York, and 6.70c., St. Louis. Reports on consumption of lead were highly favorable, and the fact that most of the large consuming industries participated in the buying gave added weight to these statements. Despite slackened activity in the automobile industry, there was a steady call for the metal from battery makers.

Daily Prices of Metals

Sept. / Oct.	Electrolytic Copper	Straits Tin	Lead		Zinc
	Refinery	New York	New York	St. Louis	St. Louis
26	17.775	45.00	6.90	6.70	6.80
27	17.775	45.125	6.90	6.70	6.80
28	17.775	45.00	6.90	6.70	6.80
30	17.775	45.00	6.90	6.70	6.80
1	17.775	44.25	6.90	6.70	6.80
2	17.775	43.675	6.90	6.70	6.80
	17.775	44.675	6.900	6.700	6.800

Average prices for calendar week ending Sept. 28, 1929, are: Copper, 17.775c.; Straits tin, 45.125c.; New York lead, 6.900c.; St. Louis lead, 6.700c.; zinc, 6.800c.; and silver, 50.542c.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices usually are quoted on a delivered basis; that is, delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices at refineries on the Atlantic seaboard. Delivered prices in New England average 0.225c. per pound above those quoted.

Quotations for copper are for the ordinary forms of wirebars and ingot bars. For ingots an extra 0.05c. per pound is charged; for slabs, 0.075c.; and for cakes, 0.125c. up, depending on weight. Cathodes are sold at a discount of 0.125c. per pound.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight differential. Contract prices for High-Grade zinc delivered in the East are 1@1½c., depending upon purity, above St. Louis prices for Prime Western.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

London

Sept. / Oct.	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic	Spot	3M	Spot	3M	Spot	3M
	Spot	3M							
26	73 13/16	74 7/16	84¼	203¼	207⅜	23 11/16	23 9/16	23 9/16	23 15/16
27	74⅛	74¾	84¼	203⅜	207⅜	23⅝	23½	23½	24
30	74 1/16	74⅝	84¼	203⅜	207⅛	23⅝	23½	23½	23 15/16
1	73⅜	73⅞	83¾	200⅛	203⅜	23⅜	23½	23⅝	24
2	73¾	74 3/16	84¼	196	200	23⅜	23 7/16	23 11/16	24 1/16

Prices for lead and zinc are the official closing prices for the morning session of the London Metal Exchange; prices for copper and tin are the official closing buyers' prices. All are in pounds sterling per long ton (2,240 lb.).

Silver, Gold, and Sterling Exchange

Sept.	Sterling Exchange "Checks"	Silver		Gold London	Sept. / Oct.	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
26	$4.84¾	50¾	23 9/16	84s11½d	30	$4.84 11/16	50	23 3/16	84s11½d
27	4.84 11/16	50⅝	23 5/16	84s11½d	1	4.85¼	50¼	23 5/16	84s11d
28	4.84 9/16	50¼	23 5/16	..	2	4.85⅛	50⅛	23¼	84s11½d

Average: Silver, 50.250c.; Sterling Exchange, $4.85010.

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of silver, 999 fine. London silver quotations are in pence per troy ounce of bar silver, basis 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command five-eighths cent premium.

Average Metal Prices for September, 1929

COPPER:	
New York Electrolytic	17.775
London Standard Spot	75.286
London Electrolytic Spot	84.363
LEAD:	
New York	6.890
St. Louis	6.689
London Spot	23.557
London Forward	23.589
SILVER:	
New York	51.042
London	23.708
Sterling Exchange	484.253
ZINC:	
St. Louis	6.799
London Spot	24.208
London Forward	24.688
TIN:	
Straits	45.359
London	204.863
QUICKSILVER	124.542
ANTIMONY	8.709
PLATINUM:	
Refined	66.000
Crude	56.000
ALUMINUM 99 Per Cent Plus	24.300

Corroders, cable manufacturers, and brass makers were also represented.

Somewhat easier lead prices in London had no apparent influence on the situation here. The undertone of the market was firm at all times, and some producers did not seem at all anxious to quote on November business. The sales volume for September was well above expectations.

Tin prices broke sharply in London, which was reflected in lower prices here. Rather bullish statistics, showing a drop in the visible supply of 1,844 tons during September, were offset as a market factor by the general unsettlement abroad attending the rise in the British bank rate. Demand here was quiet, even at the lower prices. Toward the close tin was quoted at 43⅜c., against 45c. a week ago.

Continued sales of silver by China have resulted in a further decline in price. Indian bazaars operated both ways, but speculative purchases at the lower level have had a steadying effect on the market.

Sterling exchange got close to par this week. Closing cable quotations on other important exchanges, on Tuesday, Oct. 1, were: Francs, 3.92⅛c.; lire, 5.23⅛c.; and marks, 23.84c. Canadian dollars, ⅜ per cent discount.

Mexican Dollars (old Mexican pesos): Sept. 26th, 37¼c.; 27th and 28th, 37⅛c.; 30th, 37c.; Oct. 1st, 37⅛c.; 2d, 37⅛c.

Steel Production Down 10 Per Cent in September

Pittsburgh, Oct. 2, 1929.

Slowly decreasing steel buying since April or May was reflected in only slightly decreased steel production up to Sept. 1, as mill operations were largely sustained by an accumulation of orders. In September there was less help from old orders and none of the usual seasonal increase in buying. The result was that the month closed with steel being produced at about 10 per cent under the average rate of August and about 15 per cent under the peak rate of last May. A further decrease is presaged for October and further seasonal decreases are to be expected for November and December.

By a short-range comparison, steel makes a poor showing, as a special bulge in demand began at the middle of last year and was especially marked in the first half of this year. By a long-range comparison, covering six or eight years, it can decline somewhat farther and still not be below the general trend line.

Decreased consumption is chiefly in the automobile industry, there being decreases of less tonnage importance in the agricultural-implement and freight-car shops. Fabricated structural steel demand is fully sustained. Some fresh freight-car buying is noted, and the usual seasonal rail buying movement.

Steel prices have tended to soften. Galvanized sheets weakened some three months ago and are now easier still, and black sheets are far from firm. Some sales of merchant bars have been made at 1.90c., against 1.95c., formerly quoted as the whole market.

Pig Iron—The market has been quiet, with little tendency to contract for fourth quarter. Prices are maintained at $19 for bessemer and malleable and $18.50 for basic and foundry, f.o.b. Valley furnaces.

Connellsville Coke — Furnace coke contracts for fourth quarter have been renewed at $2.75. Spot furnace is easy at $2.75. Spot foundry has declined, being now at $3.75@$4.25 for ordinary standard grades.

Zinc Output to Be Cut in Tri-State

Joplin, Mo., Sept. 28, 1929

Blende	Per Ton
High	$46.40
Premium blende, basis 60%	44.00
Prime Western, basis 60%	$43.00@ 44.00
Table concentrate, 60%	41.00@ 43.00
Flotation concentrate, 60%	39.00@ 41.00
Average price, all zinc	44.52

Galena	
High	$88.80
Basis 80% lead	87.50
Average settling price, all lead	87.27

Shipments for the week: Blende, 11,560; lead, 1,811. Value, all ores the week, $672,640.

Shipments for nine months: Blende, 481,399; lead, 77,109. Value, all ores nine months, $27,673,990.

Buyers will not acknowledge that higher than an $87.50 basis was paid for lead concentrate, but the shifting of shipments from one to another of the purchasing agencies indicates a higher offering of some kind. Zinc concentrate output was increased to 13,000 tons this week. Next week a withdrawal of 75 per cent from the production is expected. by buyers who have checked the list of mills that are to close down, and producers are making an effort to extend the shutdown over two or more weeks.

Other Metals

Quotations cover large wholesale lots, f.o.b. New York, unless otherwise specified. London prices are according to latest mail advices.

ALUMINUM—Per lb., 99 per cent plus grades, price of leading interest, 24.30c. Outside market, 99 per cent plus, 24.30c.; 98-99 per cent, 23.90c. London, 98 per cent, quoted at £95 per long ton, less 2 per cent for domestic consumption.

ANTIMONY—Per lb., duty paid: Chinese brands, for all positions, 8.60c. Sept. 26, 27, 28 and 30; 8½c. Oct. 1 and 2. Cookson's "C" grade, spot, 14c. Chinese needle, lump, 8c. Standard powdered needle, 200 mesh, 10c.

BISMUTH—Per lb., in ton lots, $1.70. Smaller lots $1.85 and up. London 7s. 6d.

CADMIUM—Per lb., 80@90c. London, 3s.10d.@3s.11d. for prompt.

CHROMIUM — Per lb., 97 per cent grade, 96c. per lb. of contained metal.

COBALT — Per lb., f.o.b. Canadian works: Shot or rondelles, 97@98 per cent, $2.50. Contract sales booked at discounts, depending on quantity. Black oxide, 70 per cent, $2.10. London, nominal, 10s. for metal in small lots, 8s. for black oxide; 8s. 10d. for gray.

[1]GERMANIUM OXIDE—Per gram in 200 to 300-gram lots, $3.50.

IRIDIUM—Per oz., $220@$230 for 98 @99 per cent sponge and powder. London, £46@£48.

[1]LITHIUM—Per oz., 98@99 per cent grade in 1- to 5-lb. lots, $5.

MAGNESIUM—Per lb., single orders for spot metal: 8-lb. ingots (3x3x15 or 16 in.), 95c.@$1.05, depending on quantity; 2½- or 3-lb. sticks (1¾ in.) 90c.@$1.10, depending on quantity; 10-oz. sticks (1x12 in.), 80@90c. Discounts up to 20 per cent on larger orders or contracts. London 3s. 3d.@ 3s. 9d. for 99 per cent ingots or sticks.

[1]MOLYBDENUM—Per lb. in 1- to 3-lb. lots, 99 per cent, $18. (Usually sold as calcium molybdate or ferromolybdenum, which see).

NICKEL—Per lb., ingot 35c.; shot 36c.; electrolytic, 35c. (99.90 per cent), for single lots of spot metal. London, per long ton, £175. Business well maintained and prices firm, according to *The Metal Bulletin*, London.

OSMIUM—Per oz., $58@$65; London, £12@£13 10s.

PALLADIUM — Per oz., $36@$38; London, £6 17s. 6d.@£7.

PLATINUM—Official price quoted by the leading interest on small miscellaneous orders for refined metal, per oz., $65. Transactions between dealers and refiners in the outside market are commonly reported at several dollars less. London, per oz., £13 10s.@£13 15s. for refined; crude and scrap, nominal at £11 10s.@£12.

QUICKSILVER—Per 76-lb. flask, $124 @$125. Market quiet and barely steady. San Francisco wires $124.33. London steady, with offers of spot at £22 10s.

RADIUM — Per mg. radium content, $70.

RHODIUM—Per oz., $45@$55. Nominal. London, £11 10s.@£13.

RUTHENIUM — Per oz., $42@$50., Nominal. London £9@£10 10s.

SELENIUM—Per lb. in 500-lb. lots; Black, powdered, amorphous, 99.5 per cent pure, $2. London, 7s. 8d.@ 7s. 9d.

TANTALUM — Per gram: Bar and heavy sheet, chemically pure, 16c.; tantalum powder, 11c.

TELLURIUM—Per oz., 15@18c.

THALLIUM METAL—$12.50@$15 per pound.

TITANIUM—Per lb., 80@90 per cent grade, $5.

TUNGSTEN POWDER—Containing 97 to 98 per cent tungsten, per lb., $1.70@ $1.75, depending on quantity.

VANADIUM—Per gram, 92@95 per cent grade, $1.25.

[1]Price furnished by Foote Mineral Company, Philadelphia.

Metallic Ores

ANTIMONY ORE—Bolivian ore, 60 per cent metallic antimony, $1.30 per short ton unit, c.i.f. New York.

CHROME ORE—Per long ton, f.o.b. Eastern shipping points, Indian and Rhodesian ores, $21.50 for 46@47 per cent Cr_2O_3 ore to $23.50 for 50@51 per cent ore. New Caledonian ore, high-grade, $25.

IRON ORE—Per long ton, lower Lake ports. Lake Superior ores:

Mesabi, non-bessemer, 51½ per cent iron, $4.50. Old Range, non-bessemer, $4.65.

Mesabi, bessemer, 51½ per cent iron, $4.65. Old Range, bessemer, 51½ per cent, $4.80.

Eastern ores, cents per unit, delivered at furnaces: Foundry and basic, 56 to 63 per cent, 8c.

Foreign ores, f.o.b. cars Atlantic ports, cents per unit:

North African, low-phosphorus, 10@10½c.

Spanish and North African basic, 55@60 per cent, 10@10½c.

Swedish foundry or basic, 66@68 per cent, 9@10c.

Newfoundland foundry, 55 per cent, 8½@9c. Nominal.

MANGANESE ORE—Per long-ton unit of Mn, c.i.f. North Atlantic ports. Exclusive of duty. Brazilian and Indian ores, minimum 47 per cent Mn, 31@34c. Caucasian, 53@55 per cent, 36c. Cuban, minimum 47 per cent, 35c. Chilean, minimum 47 per cent, 35c.

Per ton in carload lots:

[1]Chemical grades, powdered, coarse or fine, 82@87 per cent MnO_2, Brazilian, Javan, Caucasian, and Cuban, $60@$65. Domestic, 70 to 72 per cent, $40@$50.

TANTALUM ORE—Per unit of Ta_2O_5, basis 60 per cent ore, $13.

TITANIUM ORE—Ilmenite, per gross ton, 50 per cent TiO_2, f.o.b. Atlantic seaboard, $9.50@$11, according to grade and impurities. Low-grade domestic, 32 to 35 per cent, about $7@$8 per gross ton. Rutile, per lb., guaranteed minimum 94 per cent concentrate, 10c. in carload lots.

TUNGSTEN ORE—Per short-ton unit of WO_3, N. Y.: Wolframite, $15.25@$15.50 for future delivery. Bolivian scheelite is quoted at $15.50@$15.75, Oct.-Nov. shipment. Western scheelite, $16.50, Jan. shipment.

VANADIUM ORE—Per lb. V_2O_5 contained, 28c.

ZIRCON ORE—Per net ton containing 55 per cent ZrO_2, f.o.b. Atlantic seaboard, $40@$45 in 30-ton lots.

Non-Metallic Minerals

Prices received for non-metallic minerals vary widely and depend upon the physical and chemical characteristics of the commodity. Hence the following quotations can serve only as a general guide to the prices obtained by producers and dealers in different parts of the United States for their own product. In the last analysis the value of a particular non-metallic mineral can be ascertained only by direct negotiation between buyer and seller.

[1]Price given by Foote Mineral Company, Philadelphia.

[1]AMBLYGONITE—Per ton, f.o.b. mines: 8@9 per cent lithium oxide, $50@$60.

ASBESTOS — Per ton: f.o.b. Quebec mines, tax and bags included, prices quoted by leading interest for delivery on 1929 contract:

Crude No. 1, $550@$750; crude No. 2, $450@$575; spinning fibers, $225@$275; magnesia and compressed sheet fibers, $175@$225; shingle stock, $55@$115, various grades; paper stock, $45@$50; cement stock, $25; short fibers, $10@$20; floats, $12@$15. Europe reports a general shortage of Canadian spinning fiber and No. 2 crude.

Per ton c.i.f. New York: Rhodesian crude No. 1, $450; No. 2, $350.

BARYTES—Per ton: f.o.b. mines, bags extra:

Georgia: Barytes ore, crude (per long ton), $6.50. Washed and water floated to 97 per cent through 325 mesh, $18.

Missouri: Water ground and floated, bleached, $23; $25 in less than car lots, f.o.b. works. Crude ore, 93 per cent $BaSO_4$, not to exceed 1 per cent iron, $7.75@$8 f.o.b. mines.

BAUXITE—Per long ton: Domestic ore, chemical, crushed and dried, 55 to 58 per cent Al_2O_3, 1.5 to 2.5 per cent Fe_2O_3, $7.50@$8.25 f.o.b. *Alabama* and *Arkansas* mines. Other grades, 56 to 59 per cent Al_2O_3, 5 to 8 per cent SiO_2, $6.75@$8.25 f.o.b. *Arkansas* mines. Pulverized and dried, $12@$14 f.o.b. *Arkansas* mines; calcined, 78 to 84 per cent Al_2O_3, $18@$20 f.o.b. *Arkansas* mines.

Per metric ton, foreign, c.i.f. Atlantic port: Dalmatian, 50 to 55 per cent Al_2O_3, 1 to 3 per cent SiO_2, $4.50@$6.50; Istrian, 54 to 57 per cent Al_2O_3, 3 to 5 per cent SiO_2, $5.50@$7; French, 56 to 59 per cent Al_2O_3, 2 to 5 per cent SiO_2, $6@$8.

BORAX—Per lb.: Carload lots, in bags, crystals, 2¾c.; granulated or powdered, 2½c.; f.o.b. shipping point.

[1]CELESTITE—Per ton in carload lots: 90 per cent $SrSO_4$, finely powdered, $27.

CHALK—Per ton: Crude in bulk, c.i.f. *New York,* $4.75@$5.

CHINA CLAY (KAOLIN)—Per ton: F.o.b. *Virginia* mines, crude lump, No. 1, $7; crude No. 2, $5.50; washed, $8; powdered and air-floated, $8@$15; ground. $7@$15.

Florida, pressed pottery, bulk, $13; ground, No. 1, $20; No. 2, $15. Sprayed mineral flour in 100-lb. bags (bags extra), No. 1, $20; No. 2, $17. Market slow.

Best grade, domestic, $16@$18, f.o.b. *Delaware* plants in carload lots.

Imported English, f.o.b. American ports: Lump, $13@$21; powdered, $40@$45.

DIATOMITE—Per short ton, f.o.b. producing plant:

Kiln-fired brick, $65; kiln-fired aggregate, ¼ in., $45; insulating powder, $25: natural aggregate, ¼ in., $18@$20; air-floated powder, $45; 80 to 85 per cent silica, 98 per cent through 200 mesh, $20 in carload lots.

EMERY—F.o.b. *Pennsylvania* and *New York* in 350-lb. kegs, per lb.: Greek Naxos, 6½c.; Turkish, 6½c.; Khasia, 6½c.; domestic, 3½c.

FELDSPAR—F.o.b. mine or grinding plant:

North Carolina, per long ton, No. 1 pottery grade, crude, $6.50@$7.50; No. 2, glass grades, $5@$6.

No. 1, pottery, 140 mesh, $16; 200 mesh, $18. No. 2, enamel, 20 mesh. $10.25@$12; 140 mesh, $13@$16; 200 mesh, $14.75@$18; all per short ton.

New Hampshire, per ton: Pottery grade, $8. Best quality lump, $9.

New York, per ton: f.o.b. cars, No. 1 crude, $9. Soda-potash feldspar, 140 mesh, first grade, $18 per short ton; 200 mesh, first grade, $20.

Maine, per ton: Best pottery grade, ground, $19. Market fair.

FLUORSPAR — Per ton: F.o.b. *Kentucky* and *Illinois* mines:

Gravel, not less than 85 per cent CaF_2, and not over 5 per cent SiO_2, $18. Foundry lump, 85-5, $20. Ground, 95 to 98 per cent CaF_2, and not over 2½ per cent SiO_2, $32.50 in bulk; $36.50 in bags or barrels. Acid lump, 98-1, $30 in car lots.

New Mexico: 85-5 gravel, $16.50; 85-5 lump, $16.50; 94 lump, $21; ground, 96, $35.

Foreign spar, duty paid, $17, tidewater.

FULLER'S EARTH — Per ton, f.o.b. *Florida:* 16 to 30 mesh, $16.50; 30 to 60 mesh, $18; 16 to 60 mesh, $17; 60 to 90 mesh, $14; 100 mesh up, $7.

Powdered, import duty paid, $24@$25 per ton.

GARNET—Per ton; domestic, f.o.b. mines, $85.

Spanish grades, $60, c.i.f. port of entry.

GILSONITE — Per ton, carload lots, f.o.b. mines *Colorado:*

Selected grade, $33; seconds (mine run), $25.50.

GRAPHITE—Per lb., f.o.b. *New York:*

Ceylon lump, 8@9c.; chip, 6½@7½c.; dust, 3@5c.; Madagascar flake, 6½@8½c.

No. 1 flake, 8@16c.; fine ground, 5@15c. Ordinary fine ground, 4@8c.; high grade, 8@12c.; amorphous, 3@7c.

Crude amorphous graphite, $15@$35 per ton, according to grade.

GREENSAND—Per ton, f.o.b. cars, *New Jersey:* Screened and bagged, best grade, in carload lots, $20.

GYPSUM—Per ton, f.o.b. mill, depending upon location: Crushed, $1.50@$5; ground, $4@$9; agricultural, $4@$8; calcined, $4@$13.

IRON OXIDE (See Ocher)—Per lb.: Standard Spanish red, 3@4½c.; domestic earth, 2@4½c.

KAOLIN—See China Clay.

[1]LEPIDOLITE—Per ton: $20@$30 for ordinary grades. Nominal.

LIMESTONE—Per ton: f.o.b. shipping points, depending on location, either lump or crushed, 50c.@$3.

Agricultural, 75c. up to $5 for crushed or pulverized. Prices depend upon source, purity, and fineness.

MAGNESITE — Per short ton, f.o.b. *California* mines: Grade "A" calcined, 80 per cent through 200 mesh, $43; Grade B, $40; dead burned, $29; crude, $11. *Washington:* Dead-burned magnesite, $22@$24 per net ton, Chewelah, Wash.

MICA—Per ton, f.o.b. plant:

New Hampshire: Mine run sheet and punch, $320@$360; clean shop scrap, $22.50@$27.50; roofing, $30@$35. White dry ground, 20 mesh, $28; 40 mesh, $40; 60 mesh, white, $60; off-color, $34; 100 mesh, $65; 200 mesh, $80. Granite mica facings for cement block and stucco use, $8@$12, depending on size between ¼ in. and 60 mesh. Disks, 1¼ in. No. 1, per lb., $1.25; 2½x2 in. square cuts, $3.25.

North Carolina: White, ground, 20 mesh, $35; 70 mesh, $100.

Madagascar, amber, per lb., f.o.b. *New York*, duty paid: No. A1, $2.50; No. 1, $2; No. 2, $1.65; No. 3, $1.15; No. 4, 60c.; No. 5, 45c.

[1]MONAZITE—Per ton: (Minimum 6 per cent ThO_2), $60.

OCHER — F.o.b. *Georgia* mines, per ton: $19@$20 in sacks; $21@$22 in barrels; washed and water floated, $18; second grade, 99 per cent through 225 mesh, $18.

PHOSPHATE—Per long ton, f.a.s. or f.o.b. mines:

Florida, pebble, f.a.s., for export: 76@77 per cent, $7.15; 75 per cent, $6.40; 74@75 per cent, $6.15; 70 per cent, $4.65; 68 per cent, $4.10.

Florida, pebble, domestic: 76@77 per cent, $6.50; 74@75 per cent, $5.50; 72 per cent, $4.50; 70 per cent, $4. Dull.

Tennessee, ground, 80 per cent through 300 mesh, 33 per cent P_2O_5, $11.80 per short ton. Brown lump for acid manufacture, per gross ton, $6 on 75 per cent basis; $5.25 on 72 per cent basis. Non-acidulated, fine ground, 65 per cent, $8 (per short ton).

POTASH—The ruling contract prices (short tons) are as follows:

	Bags	Bulk
Muriate of potash, 80@85 per cent, basis 80 per cent..	$36.75	$35.15
Sulphate of potash, 90@95 per cent, basis 90 per cent	47.75	46.15
Sulphate of potash-magnesia, 48@53 per cent, basis 48 per cent	27.50	25.90
Manure salt, 30 per cent...	21.95	18.95
Manure salt, 20 per cent...	15.50	12.50
Kainit, 14@16 per cent ...	12.60	9.60
Kainit, 12.4 per cent.....	12.10	9.10

PUMICE STONE—Per lb.: In barrels, powdered, 2½@4c.; selected lump, 5@7c.

PYRITES—Per long ton unit of sulphur: C.i.f. United States ports; guaranteed 48 per cent sulphur: Spanish, 13c.; Tharsis, furnace size, 2½ in. diameter, 14c. Cinder from ore to remain property of buyers.

[1]QUARTZ ROCK CRYSTALS—Per lb. in ton lots: Colorless, clear but flawed, pieces ¼ to ½ lb. in weight, 20c. Flawless, for optical purposes, four times above price; larger crystals still higher.

SILICA—Per ton: Water ground and floated, in bags, f.o.b. Illinois: 325 mesh, $16@$40 for 92 to 99½ per cent grades. Market fair. Glass sand, f.o.b. producing plant, 75c.@$5 per ton; molding sand, 65c.@$3.50; blast sand, $1.35@$3.50.

[1]SPODUMENE — Per ton: $20@$30, depending upon lithium content.

SULPHUR—Per long ton for domestic market, $18 f.o.b. Texas mines; $22 for export, Atlantic ports.

TALC—Per ton, carload lots, f.o.b. works, containers included:

Vermont: 99 per cent through 200 mesh, extra white, $9@$9.50; 97½ to 98½ per cent through 200 mesh, medium white, $8.50@$9; packed in 50-lb. paper bags; prices $1 per ton less in burlap sacks plus 15c. net for bags packed 12 to the ton.

New York: Double air-floated, short fiber, 200 mesh, $13.75; 325 mesh, $14.75@$16.50.

Georgia: Powdered, gray, $7.50@$10; yellow, $9@$12; red, $11@$13; roofing, $7.50@$9.

New Jersey: Soapstone, ground, $10@$12.

TRIPOLI—Per short ton, burlap bags, paper liners, minimum carload 30 tons, f.o.b. *Missouri:* Once ground through 40 mesh, rose and cream colored, $16. Double ground through 110 mesh, rose and cream, $18. Air-floated through 200 mesh, rose and cream, $27.50; mill run, $16. Demand quiet.

Metallic Compounds

ANTIMONY OXIDE—White, Chinese, 99 per cent Sb_2O_3, 10½@11c. per lb. Nominal.

ARSENIOUS OXIDE (White arsenic)—Per lb., 4c.; delivered all positions. Market steady. London, per long ton, £16 for Cornish white.

CALCIUM MOLYBDATE OR MOLYTE — Per lb. of contained Mo, 95c.@$1.

COPPER SULPHATE (Blue Vitriol)—Per lb. in car lots, 6c., for either large or small crystals.

SODIUM NITRATE—Per 100 lb.; crude natural, in bags ex vessel, Atlantic ports, $2.10 for October deliveries.

SODIUM SULPHATE (Salt Cake)—Per ton, bags, f.o.b. works, $19@$22; in barrels, $23@$25.

ZINC OXIDE—Per lb. in bags, in car lots: Lead-free, 6½c.; 10, 20 or 35 per cent leaded grades, 6¼c.; French red seal, in bags, 9½c.

[1]Price furnished by Foote Mineral Company, Philadelphia.

Alloys

[1]FERROCERIUM—Per lb., $8 in 100-lb. lots.

FERROCHROME—Per lb. of contained chromium, 60@70 per cent chromium, 4 to 6 per cent carbon, 11c. on requirement contracts; spot shipments about 11½c. Freight allowed on carload lots east of Mississippi River and north of Baltimore.

FERROMANGANESE — Per gross ton furnace: Domestic and foreign, 78@82 per cent, $105. Spiegeleisen, 19@21 per cent, $34 on carload business, f.o.b. furnace.

FERROMOLYBDENUM—Per lb. of Mo, f.o.b. shipping point, 50@60 per cent Mo, $1.20.

FERROPHOSPHORUS—Per ton, 18 per cent P, $91; electrolytic, 24 per cent, $122.50; f.o.b. *Alabama* and *Tennessee*.

FERROSILICON—Per gross ton, f.o.b. works, freight allowed on carload lots east of Mississippi River and north of Baltimore: 50 per cent, $83.50; 75 per cent, $130; 15@17 per cent, $45, f.o.b. Suspension Bridge, N. Y. Quotations for spot shipments $5@$10 per ton higher on 50 and 75 per cent grades.

FERROCARBONTITANIUM — Per ton: $160, f.o.b. producer's plant.

FERROTUNGSTEN—Per lb. of W contained, 75@80 per cent W, $1.45@$1.50, f.o.b. works.

FERROVANADIUM—Per lb. of V contained, f.o.b. works, freight allowed east of Mississippi, $3.15@$3.50, depending on grade and quantity.

NICKEL SILVER—Per lb. for 18 per cent nickel Grade A sheets, 34½c.

YELLOW (MUNTZ) METAL—Dimension sheets, per lb., 25c.; rods per lb., 22½c.

Rolled Metals

COPPER—Sheets, hot-rolled, per lb., 27¾c.; wire, per lb., f.o.b. mill, 19⅞c.

LEAD SHEETS—Full rolled, 11c. per lb.; clipped, 11½c.

MONEL METAL—Per lb., sheets, full finished, 42c.; rods, hot-rolled, 35c.

NICKEL—Per lb., sheets, full finished, 52c.; rods, hot-rolled, 45c.

ZINC SHEETS—Per lb., 10½c., f.o.b. works.

Refractories

CHROME BRICK—Per net ton, f.o.b. shipping point, $45.

FIRECLAY BRICK — Per M.: First quality, $43@$46, *Ohio, Kentucky, Central Pennsylvania;* second quality, $35@$38.

MAGNESITE—Brick, per net ton, f.o.b. works: 9-in. straights, $65, f.o.b. plant. Cement, $40, seaboard.

SILICA BRICK—Per M., *Pennsylvania* and *Ohio*, $43; *Alabama*, $51; *Illinois*, $52.

ZIRKITE—Per lb.; Powdered, 65@70 per cent ZrO_2, 3½c. Brick, straights, 80c.@$1 each.

Mining Stocks—Week Ended September 28, 1929

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Anaconda Copper	New York	127¼	115¾	116¾	Oc. 11, No. 18 Q	1.75
Andes Copper	New York	57	51½	51½	Oc. 11, No. 11 Q	0.75
Arizona Com	Boston	2½	1½	1½	Jl. 16, Jl. 31 SA	0.25
Calumet & Ariz.	New York	126½	124½	124½	Se. 6, Se. 23 Q	2.50
Calumet & Hecla	Boston	44½	41½	41½	Au. 31, Se. 30 Q	1.00
Cerro de Pasco	New York	96½	92½	92½	Jl. 11, Au. 1 Q	1.50
Con. Coppermines	N. Y. Curb	9½	9	9		
Copper Range	Boston	23½	21½	21½	Se. 14, Oc. 15 Q	0.50
East Butte	Boston	2½	1½	2	Dec., 1919	0.50
Granby Con.	New York	89	85	85½	Oc. 18, No. 1 Q	2.00
Greene Cananea	New York	189	175	175	Se. 12, Oc. 7 Q	2.00
Howe Sound	New York	65½	60¾	61½	Se. 30, Oc. 15 Q	1.00
Hudson Bay	N. Y. Curb	17½	16½	17		
Inspiration	New York	45¾	41	41¾	Se. 9, Oc. 7 Q	1.00
Isle Royale	Boston	23	21¾	22	Au. 31, Se. 30	0.50
Kennecott	New York	87½	81½	82½	Au. 30, Oc. 1 Q	1.25
Magma Copper	New York	72	68½	70	Se. 30, Oc. 15 Q	1.25
Mason Valley	N. Y. Curb	2	1½	2		
Miami Copper	New York	44	40½	40¾	Au. 1, Au. 15 Q	1.00
Mohawk	Boston	61½	58	58	Jl. 31, Se. 2 Q	2.00
Mother Lode	New York	2½	2½	2½	Je. 13, Je. 29	0.20
Nevada Con.	New York	48½	43½	44½	Se. 18, Se. 30 Q	0.75
Noranda	N. Y. Curb	58½	53¾	54¾		
Ohio Copper	N. Y. Curb	1½	1½	1½	Sept., 1926	0.03
Old Dominion	Boston	9	7½	7¾	Dec., 1918	1.00
Phelps Dodge	New York	65	58½	59	Se. 4, Oc. 1 Q	0.75
Quincy	Boston	44½	42	42	March, 1920	1.00
Roan Antelope	N. Y. Curb	44¾	40½	40½		
St. Mary's M. L.	Boston	40	38	38	Fe. 25, Mr. 12	2.00
Seneca Copper	New York	5	4¾	4¾		
Shattuck Denn	N. Y. Curb	15	14	14		
Sherritt-Gordon	Toronto	6.90†	6.20	6.20		
Tenn. C. & C.	New York	18¾	17½	17½	Au. 31, Se. 16 Q	0.25
United Verde Ex.	N. Y. Curb	16¼	16¼	16¼	Oc. 2, No. 1 Q	1.00
Utah Copper	New York			325	Se. 18, Se. 30 Q	4.00
Waite-Ack.-Mont.	Toronto	5.75	5.00	5.00		
Walker Mining	Salt Lake	6.25	5.95	5.95		
Wenden Copper	N. Y. Curb	1.00	*87½	*93¾		
LEAD, ZINC, SILVER						
Ahumada Lead	New York	1¼	1½	1½		
Amer. Z. L. & S.	New York	22½	19½	20	May, 1917	1.00
A. Z. L. & S., pfd.	New York	102½	99	99	Se. 19, Oc. 1 Q	1.50
Bunker Hill & S.	N. Y. Curb			145½	Au. 22, Se. 5 X	0.75
Butte Cop. & Zn.	New York	4¼	3½	3½		
Butte Cop. Con.	Boston Curb	*75	*62½	*68¾		
Butte & Sup.	New York	7¾	7¼	7¼	Je. 14, Je. 29 Q	0.50
Callahan Zn-Ld.	New York	2¾	2	2	Dec., 1920	0.50
Chief Consol.	Salt Lake	†3.25	†3.00	....	Fe. 1, 1928 K	0.10
Consol. Ld. & Zn. "A"	St. Louis	10	9½	9¾	Se. 20, Oc. 1 Q	0.25
Constitution	Spokane	*54	*45	*45		
Davrock	Spokane	3.00	3.00	3.00	Je. 20, Je. 30	0.03
Dickens Consol.	Spokane	*7½	*7¾	*7½		
Eagle-Picher	Cincinnati	17	16½	16½	Je. 30, Jl. 15 Q	0.20
Eagle-Pich., pfd.	Cincinnati	....	....	103	Je. 30, Jl. 15 Q	1.50
Erupcion	Boston Curb	....	....	*12	Ja. 1, 1928 Q	0.07½
Eureka Bullion	Salt Lake	*97	*93	*95		
Evans-Wallower	N. Y. Curb	17½	16¾	17½		
Evans-Wal., pfd.	N. Y. Curb	80	70	80	Je. 20, Jl. 1 Q	1.75
Federal M. & S.	New York	241	237	237	Je., 1927	10.00
Fed. M. & S., pfd.	New York	99	99	99	Au. 23, Se. 16 Q	1.75
Gladstone	Spokane	*5	*4¾	*4¾		
Golconda	Spokane	*93	*82	*82	Je. 15, Jl. 1	0.02
Grandview	Spokane	*30¾	*29½	*29½		
Hecla Mining	N. Y. Curb	17¾	17	17	Au. 15, Se. 15 Q	0.25
Highland-Surprise	Spokane	*15½	*13½	*13½		
Jack Waite	Spokane	*17	*11¾	*13		
Kootenay Florence	Spokane	*12½	*11½	*12		
Lucky Jim	Spokane	*14¼	*14	*14		
Lucky Tiger-C.	Kansas City	†3.00	†2.87½	....	Se. 10, Se. 20	0.02½
Mexican Premier	Spokane	2.25	2.20	2.23		
National Lead	New York	185	176½	185	Se. 13, Se. 30 Q	1.25
Natl. Lead, pfd. A	New York	140	139	139	Au. 30, Se. 14 Q	1.75¾
Natl. Lead, pfd B	New York	116	116	116	Oc. 18, No. 1 Q	1.50
N. J. Zinc, new	N. Y. Curb	86	84½	85	Oc. 21, No 9 Q	0.50
New Quincy	Salt Lake	2.22½	2.05	2.05	Se. 20, Se 30 Q	0.10
Noble Five	Spokane	*58	*55	*55		
North Lily	Salt Lake	5.50	5.10	5.25	Jl. 16, Jl. 20 Q	0.25
Park Bingham	Salt Lake	6.25	6.25	6.25		
Park Utah	New York	4.50	4.00	4.00	Dividends suspended	
Pend Oreille	Spokane	4.25	4.00	4.00		
Rico Argentine	Salt Lake	*31	*30	*30	No. 30, De. 15 Q	0.03
Ruth-Hope	Spokane	*38	*33	*33		
St. Joseph Lead	New York	68	62½	65	Se. 10, Se. 20 QX	0.75
Sherman Lead	Spokane	*67½	*62	*67		
Silver King Coa.	Salt Lake	12.75	12.50	12.50	Se. 20, Oc. 1 Q	0.25
Silversmith	Spokane	*9½	*8	*8	Oct., 1926 Q	0.02
Sunshine Mining	Spokane	5.82½	5.15	5.15	Se. 10, Se. 20 Q	0.05
Tamarack-Custer	Spokane	*56	*52	*56	Sept., 1924	0.25
Tintic Standard	Salt Lake	12.87½	12.00	12.00	Se. 17, Se. 20 X	0.30¾
Tonopah Belmont	N. Y. Curb	*56½	*56½	*56½	Oct., 1925	0.05
Treadwell-Yukon	Toronto	....	....	9.00		
United Zinc Smg.	N. Y. Curb	....	....	*68¾		
Utah Apex	Boston	3½	3	3	May 15, June 1	0.25
Utah Met. & Tun.	Boston	1.00	*90	1.00	Dec., 1917	0.30
Whitewater	Spokane	*45	*35	*40		
Yellow Pine	Los Angeles	....	....	*8	Dec., 1925 QX	0.04
GOLD						
Alaska Juneau	New York	7¾	7½	7½		
Barry-Hollinger	Toronto	*20½	*16	*20		
Central Manitoba	Toronto	*35	*32	*33		
Cresson Consol.	N. Y. Curb	*56¾	*43¾	*56	Se. 30, Oc. 10 Q	0.02
Dome Mines	New York	9¾	8¾	8¾	Se. 30, Oc. 21 Q	0.25
Golden Cycle	Col. Springs	†1.72	†1.65	....	Au. 31, Se. 10 Q	0.04
Hollinger	Toronto	6.00	5.40	5.50	Se. 20, Oc. 7 FW	0.50
Homestake	New York	87	84¾	86½	Au. 20, Au. 26 H	0.50
Kirkland Lake	Toronto	*60	*50	*60		
Lake Shore	Toronto	22½	*20½	21	Je. 1, Je. 15 Q	0.20
McIntyre Porcupine	New York	14	13¾	13¾	Au. 1, Se. 2 Q	0.25
Portland	Colo. Springs	†*5½	†*4½	....	April, 1927	0.02
Rand Mines	New York			35½	Au. 21, '29 Am. Sh.	1.51
Siscoe	Toronto	1.10	*93	*99		
Sylvanite	Toronto	*80	*75	*80		
Teck-Hughes	Toronto	5.75	5.30	5.40	Jl. 18, Au. 1	0.15
Tom Reed	Los Angeles	*61	*60	*60	Dec., 1926	0.02
Unity Gold	N. Y. Curb	1¾	1	1¾		
Vipond Consol.	Toronto	*72	*66	*66	April, 1927	0.03
Wright-Hargreaves	Toronto	1.55	1.49	1.50	Oc. 16, No. 1	0.02½
Yukon-Alaska	N. Y. Curb	....	....	35¾		
GOLD AND SILVER						
Carnegie Metals	N. Y. Curb	18¾	16¼	17¾		
Castle-Trethewey	Toronto	*31	*30	*31		
Consol. Cortes	N. Y. Curb	12½	*12½	*12½		
Dolores Esperanza	N. Y. Curb	*62½	*37½	*43½	July, 1923	0.05
Keeley	Toronto	*49	*44	*49	Mr. 15, 1928	0.04
Mining Corp.	Toronto	4.15	3.95	4.00	My. 30, Je. 13	0.12½
Montana-Mines Corp.	Spokane	*50	*45½	*49		
N. Y. & Hond. Ros.	N. Y. Curb	15½	15½	15½	Jl. 17, Jl. 27 QX	0.50
Nipissing	N. Y. Curb	2¾	2½	2¾	Se. 26, Oc. 21 Q	0.07½
Premier Gold	N. Y. Curb	1¾	1½	1½	Se. 12, Oc. 3 Q	0.06
Tonopah Exten.	N. Y. Curb	....	....	*10	April, 1925	0.05
Tonopah Mining	N. Y. Curb	2½	2½	2½	Se. 30, Oc. 21	0.07½
United Eastern	N. Y. Curb	....	....	*25		
Yukon Gold	N. Y. Curb	*93¾	*87½	*93¾	June, 1918	0.02
IRON AND STEEL						
Bethlehem Steel	New York	123¾	114	115¾	Oc. 18, No. 15 Q	1.50
Beth. Steel, pfd, 7%	New York	126	125	125	Se. 6, Oc. 1 Q	1.75
Cleveland-Cliffs	Cleveland	97½	96½	97	Se. 5, Se. 15 Q	1.00
Colo. Fuel & Iron	New York	68½	62½	64½		
Colo. F. & I., 1st pfd.	New York	....	....	137½	Au. 10, Se. 26, Q	2.00
Great Northern Iron.	New York	30¾	23¾	30	Dec. 15, K	2.00
Inland Steel	New York	102	96	97	Au. 15, Se. 1, Q	1.87½
Republic I. & S.	New York	141¾	124½	129	My. 11, Je. 1, Q	1.00
Republic I. & S., pfd.	New York	111¾	110	110	Je. 12, Jl. 1, Q	1.75
Sloss-Sheffield S. & I.	New York	51½	51½	51½	Mr. 11, Mr. 20, Q	1.50
Sloss-Sheff. S. & I., pfd.	New York	....	....	74½	Se. 20, Oc. 1, Q	1.50
U. S. Steel	New York	241¾	222	225	Au. 29, Se. 28, Q	1.75
U. S. Steel, pfd.	New York	143¾	142¾	143	Au. 5, Au. 30, Q	1.75
Virginia I. C. & C.	New York	...	...	20	Jan., 1924	1.50
Virginia I.C.& C., pfd.	New York	...	...	43	Jl. 16, 1928	SA 2.50
MISCELLANEOUS						
Aluminum Co. of Am.	N. Y. Curb	450	404½	415		
Alum. Co. of Amer., pf.	N. Y. Curb	107½	107½	107½	Mr. 15, Ap. 1, Q	1.50
American Metal	New York	75½	72¾	73½	Au. 21, Se. 1 Q	0.75
Amer. Metal, pfd., 6%	New York	127½	125½	127	Au. 21, Se. 3 Q	1.50
Amer. Sm. & Ref.	New York	120½	111½	112	Je. 30, Jl. 12 Q	1.00
Amer. Sm. & Ref., pfd.	New York	135¾	135	135¾	Au. 3, Se. 1 Q	1.75
Ang. Ch. Nitrate	N. Y. Curb	36¾	35½	35½		
Asbestos Corp.	Montreal	6	4½	4½	Jan. 1926	1.50
Asbestos Corp., pfd.	Montreal	20	15	15	De. 31, Ja. 15 Q	1.75
Consol. M. & S.	Montreal	405	400	400	Je. 29, Jl. 15, SA	6.25
De Beers Consol.	New York	....	....	21	Jl. 23, Jl. 26, Q	0.96
Federated Metals	N. Y. Curb	37¾	34½	34½	Oc. 3, Oct. 11 Q	0.25
Freeport Texas	New York	46¼	43½	43½	Oc. 15, No. 1 Q	1.00
Int. Nickel Can.	New York	59½	54½	57½	Au. 31, Se. 30 Q	0.25
Int. Nickel, pfd.	New York	....	....	122½	Se. 28, No. 1 Q	1.75
Mayflower Assoc.	N. Y. Curb	101½	99½	101½		
Metal & Mining	N. Y. Curb	19¼	18¾	19	Se. 21, Oc. 1	0.30
Newmont	N. Y. Curb	229	219½	220½	Se. 30, Oc. 15 Q	1.00
Patiño M. & E.	New York	39¾	37½	37½	Au. 31, Se. 28, Am. Sh.	0.97
So. America G. & P.	N. Y. Curb	1½	1½	1½		
Texas Gulf Sulphur	New York	71½	67½	67¾	Se. 2, Se. 16 Q	1.00
U. S. Sm. R. & M.	New York	51½	48½	49	Oc. 7, Oc. 15 Q	0.87½
U. S. Sm. R. & M., pfd.	New York	53¾	52	52	Oc. 7, Oc. 15 Q	0.87½
Vanadium Corp.	New York	94¾	83	85	Au. 1 Au. 15 Q	0.75

Toronto Standard Stock Exchange, Toronto, courtesy the Arthur E. Moysey Co.; Salt Lake Stock Exchange, courtesy J. A. Hogle & Co. and Logan & Bryan, New York; Standard Stock Exchange, Spokane, courtesy Pohlman Investment Company.

*Cents per share. †Bid or asked. Q, Quarterly. A. Annually. SA, Semi-annually. M, Monthly. BM, Bimonthly. FW, Four weeks. K, Irregular. I, Initial. R, Resumption. X, Extra. The first date given is that of the closing of the books; the second that of the payment of the dividend.

LONDON QUOTATIONS—WEEK ENDED September 17, 1929

	High	Low	Last	Date	Amount
Alaska Mexican ($5)	20/—	20/—	20/—		
Alaska Treadwell (25)	56/—	55/—	55/—	Nov., 1926	4 p.c.
Aramayo Mines (25 frs.)	58/9	58/—	58/9	Aug., 1929	5 p.c.
Burma Corp (10 rupees)	18/1½	17/6	17/10½	July 1929	9 annas*
Bwana M'Kubwa (5s)	34/—	30/9	32/3		
Camp Bird (2s)	2/10½	2/1½	2/7½	April, 1928	16¾ p.c.
El Oro (5s)	3/1½	2/9	3/—	Nov., 1924	2½ p.c.*
Frontino & Bolivia (£1)	6/10½	6/10½	6/10½	Jan., 1929	3½ p.c (c)
Mexican Corpn. (£1)	17/6	17/—	17/3		
Mexico Mines of El Oro (£1)	7/6	6/3	6/3	Dec., 1926	3½ p.c.*
Mount Isa (£1)	40/7½	38/9	40/—		—
N'Changa Copper Mining. (£1)	75/—	69/6	71/3		
Oroville Dredging (4s)	1/9	1/9	1/9	Nov., 1928	3½ p.c.
Rhodesian Congo Border (£1)	10/-	9¾	9¾		
St. John del Rey (£1)	18/3	16/1½	17/9	Apr., 1929	7½ p.c.
San Francisco Mines (10s)	35/6	35/—	35/6	June 1929	15 p.c.
Santa Gertrudis (£1)	10/3	9/9	10/3	July 1929	7½ p.c.
Selukwe (2s. 6d.)	8/3	5/7½	7/3	April, 1917	6¾ p.c.
S. Amer. Copper (2s.)	3/—	2/9	2/9	Nov. 1917	75 p.c.
Tanganyika (£1)	63/9	59/4½	60/—	July, 1929	5 p.c.
Union Miniere du Haut-Katanga (Brussels)	11,925	11,300	11,785	April, 1929	300 fr.(‡)

*Free of British income tax. †Swiss francs and plus 15 p. c. bonus. ‡Belgian francs and free of taxation. (d) U. S. Dollars. (e) July, 1929, ex ‡d. return of capital. (e) on original £1 shares.